ANNALS OF SURGERY

VOL. LIX APRIL, 1914 NO. 4

ORIGINAL MEMOIRS.

THE METHODS SUGGESTED FOR BONE TRANSPLANTATIONS.

BY CLARENCE A. McWILLIAMS, M.D.,

OF NEW YORK,

Assistant Surgeon, Presbyterian Hospital.

BONE transplantation has become a well recognized and successful surgical procedure. Perhaps no other one thing in surgery has created a greater discussion than the function of the periosteum in bone transplants and what it accomplishes. To understand the subject it will be necessary to give the three views of leading authorities as to the life of grafts:

1. The universally accepted view in Germany is that of Axhausen, who maintains that the bone in a graft always dies, is absorbed and is reformed from the periosteum, which alone remains living in transplants.

2. The second view is that of Macewen, of Glasgow, who says that the bone in a graft is reproduced from the proliferation of osteoblasts, derived from the osteoblasts within the bone of the graft itself, and its regeneration takes place independently of the periosteum, whose only function is that of a limiting membrane, which prevents the spread of the osteoblasts into the surrounding tissues.

3. The third view is that of Murphy, who says that the graft is not osteogenetic but simply osteoconductive. Provided it be in contact at one or both extremities with other living bone, the graft acts simply as a scaffolding for the growth of the capillaries with their osteogenetic cells as they advance from

the living, contacting extremities into the graft. The periosteum takes no part in the actual reproduction of new bone.

To analyze Dr. Murphy's transplantations a little further, I may say that I have gone through all of his reported transplantations with the object of finding out just what was done with the periosteum in each procedure. In a number of cases this was not stated. In all such instances I have ascertained from him in writing exactly what was done with the periosteum. In not a single instance did he omit to transplant grafts with more or less of their covering periosteum. From a practical stand-point I judge that he does not know just what would have happened had he transplanted grafts without their periosteum, so that his conclusions as to the function of the periosteum are conjectural only.

We know that practically every graft made with its periosteum will permanently live, if asepsis be attained. What will happen to grafts made without their periosteum? Following the publication of Macewen's monograph, "The Growth of Bone," in which no osteogenetic power is attributed to the periosteum, I made four human transplantations without periosteum and in every case the graft was ultimately absorbed. That led me to perform a large number of animal experiments, which are published in full in *Surgery, Gynecology and Obstetrics,* Feb., 1914, and in the *Journal of the American Medical Association,* Jan. 31, 1914. Every graft made with periosteum lived. Of 25 grafts made without periosteum but 48 per cent. lived. That led me to conclude that the blood supply of the graft was the all important factor. Since we have no way of knowing in which cases the blood supply will be sufficient, if grafts be without their periosteum, the conclusion seems irresistible that grafts should always be made with periosteum upon them. This will assure subsequent life to practically every graft so made, if asepsis be attained. The conclusions that I formulated, with a proof of each, are as follows (they form a fairly complete set of rules for making transplantations):

1. If a section of the whole diameter of a bone be removed,

then the bone will regenerate between the ends of the fragments, if the whole, or a part of the periosteum, bridging the defect, be preserved. Proof:

Fig. 1. Experiment 3. This animal was killed eight months after subperiosteally resecting a section of a rib. This rib without periosteum was then split into longitudinal strips and these were transplanted into the abdomen. Result: The defect in the rib, from which the periosteum was not removed, has become entirely filled in with new bone. The strips, transplanted into the abdomen have remained intact, have grown together, and have increased in size. A photomicrograph of a section of this abdominal transplanted bone, shows bone perfectly alive, not undergoing absorption, and containing well preserved and normal marrow. I attribute the living of these transplants to the fact that the splitting of the original rib allowed sufficient blood to get to the bone cells.

This is a refutation of Dr. Murphy's conclusion, in which he says that bone, with or without its periosteum, when transplanted into the soft parts and not in contact with living bone, always becomes absorbed. This was one of the cases in which the graft transplanted without periosteum did not become absorbed. I have a number of such experiments.

2. If a section of the whole diameter of a bone be removed, there will take place very little subsequent filling in of this defect by new bone, if the entire periosteum has been removed from between the ends of the fragments. To have such a defect fill in, it is necessary that there shall be left either some portion of periosteum or a thin layer of bone, bridging the defect. Proof:

Fig. 2. Experiment 2. This picture was taken six months after resecting the whole diameter of a rib, together with its periosteum. The defect has not at all closed in, due to the lack of periosteum. The periosteum was stripped bluntly from the bone section and this strip of periosteum was transplanted into the abdomen (*A*). Result after seven months: A transverse section was cut through this periosteum (*A*), which was felt to be bone. A microphotograph of this section gives a picture of normal, healthy, living bone, surrounded by a closely investing, connective tissue capsule. There are no osteoclasts present nor any round cells, suggestive of either a destructive or an inflammatory process.

This result shows that transplanted periosteum may produce living bone, contrary to Macewen and Murphy's opinions.

3. Provided that a graft be living and taken from the same patient, who is to be grafted, its future life depends on an efficient blood supply, irrespective of either the periosteum, or whether the graft is in contact with living bone or not. This conclusion I desire to most emphatically emphasize. The blood supply seems to be favorably influenced by the periosteum, since 100 per cent. are successful with it and but 48 per cent. without it. Hence the teaching is clear to always transplant grafts with periosteum.

4. If minute fragments of a living graft be transplanted, then the periosteum may more readily be disregarded because the osteoblasts in the fragments may not die because of an easier access of blood to them, and the pieces of bone may grow and coalesce and not become absorbed. My statistics show that 50 per cent. of such procedures will be successful. Proof:

Fig. 3. Experiment 9. This animal was killed five months after one inch of the radius was removed, together with its periosteum. The periosteum was then scraped off the fragment, which was split into as small pieces as possible with the rongeur. The small fragments were replaced, filling in the defect in the radius. Result: The small fragments have all remained alive, have coalesced into one piece, which has become united to the ends of the radius fragments.

This experiment illustrates the influence of a good blood supply upon grafts. See also Macewen's case under "Methods of Bone Transplantation," No. 1.

5. If a large piece of living bone be transplanted, then it is much safer to leave the periosteum attached to the graft, in order to be sure of its future re-formation, since otherwise the osteoblasts in the bone of the graft will probably die because cut off from a sufficient blood supply. The periosteum survives because of its adequate blood supply from the surrounding tissues, its inner surface forms osteoblasts, which themselves proceed to re-form the bone of the graft, in the event that the osteoblasts within the transplant itself have died from a deficient blood supply. My statistics show that 41 per cent. of procedures are successful in which large grafts without periosteum are transplanted. Proof:

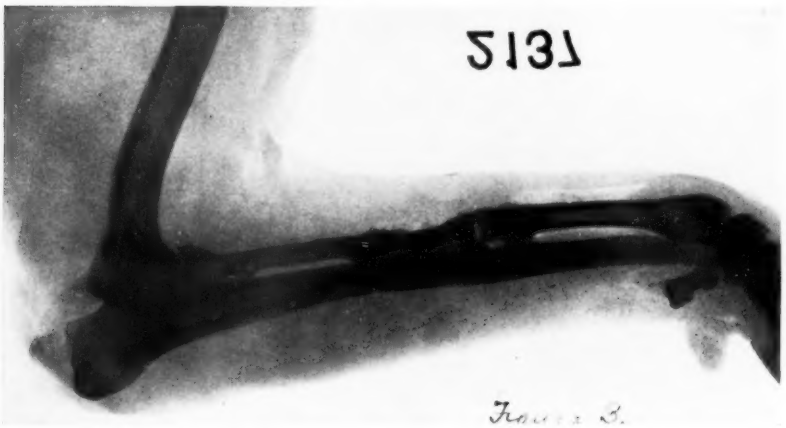
FIG. 1.

Experiment 3. Strips of a rib without periosteum, transplanted into the abdominal wall, not in contact with living bone, have remained living and have grown together.

FIG. 2.

Experiment 2. Strip of periosteum without bone, *A*, transplanted into the abdomina wall, has produced new bone.

FIG. 3.



Experiment 9. Small fragments without periosteum, transplanted into a defect in the radius, have lived and have all grown together.

FIG. 4.

Experiment 23. Right fibula without periosteum transplanted into left fibula defect in contact with old stumps has entirely disappeared. Into muscle of right leg was transplanted the left fibula with periosteum. This has remained living, although it was not in contact with living bone.

FIG. 5.

Experiment 26. Piece of periosteum from right fibula section, transplanted into muscles of left leg, has produced new bone. Right fibula segment into left defect without periosteum has disappeared. Left fibula segment transplanted into muscles of right leg with periosteum with no bony contact has remained living.

Fig. 4. Experiment 23. Dog 423. Operation: A section from the right fibula intact without periosteum was transplanted into left fibula defect in contact with old stumps. The stumps of the right fibula defect were covered with muscle, which was sutured over them. Under fascia of right leg was placed the entire section from the left fibula with periosteum still on it uninjured, there being no contact of this graft with living bone. Result 81 days after the operation: The section into the left fibula defect without periosteum has almost completely disappeared. There is a slight line left indicating a persistence of some of it. This disappearance has occurred notwithstanding that it was in contact at both ends with living bone. The difference the presence or absence of the periosteum makes is indicated in the right leg. The section from the left fibula into the right fibula defect with periosteum has remained of its original size and seems perfectly alive, this notwithstanding that it was not in contact with living bone.

This experiment is another evidence that Murphy is not correct in his statement that grafts must be in contact with living bone in order to live. This experiment would also seem to indicate that the periosteum is the important element in maintaining the life of grafts, probably due to its influencing favorably the blood supply.

6. Periosteum alone when transplanted into the soft parts may produce living bone. Proofs: Experiment under conclusion 2, also the following:

Fig. 5. Experiment 26. Dog 426. Sections from each fibula were excised. From the section from the right side, all the periosteum was bluntly stripped off from all its sides in one piece. This piece of periosteum was vertically stretched out under skin of left leg. The bone itself from the right fibula without periosteum was placed in contact with the ends of the old stumps in the left fibula defect. Over the ends of the stumps of the right defect in fibula, muscle was sutured so that the graft would not be in contact with living bone and in the superficial muscles of the right leg was placed the section from the left fibula with its periosteum entire. Result 102 days after operation: The section of bone with periosteum in right leg, not in contact with living bone, has grown to two or three times its normal size and is certainly perfectly alive. The piece of fibula without periosteum into left defect from right fibula has entirely disappeared. This is probably due to the fact that the bone was transplanted entire. Had it been split, as in the preceding two experiments, it more than likely would have survived, due to the consequent better blood supply. The periosteum on the other hand, transplanted under the skin of left leg, has developed a new mass of bone of the size and shape of the old fibula from which it was taken.

7. Contact with living bone is not necessary for the subsequent life and permanency of living grafts, as has been maintained by Murphy: Experiment 26, under conclusion 6, Fig. 5.

8. From a consideration of all the foregoing facts, the conclusion seems irresistible that bone grafts of whatever size should be transplanted with as much periosteum covering their surfaces as is possible, if one is to be positively assured of their subsequent survival. It seems probable that the influence of the periosteum is exerted in maintaining the nutrition of the graft. We must conclude that both Macewen and Murphy are mistaken in their conceptions of the lack of function of the periosteum in maintaining the life of grafts. Murphy must likewise revise his conclusion that the graft is not osteogenetic in itself, that it is simply osteoconductive of cells into the graft from the contacting living bone. I have proved that contact with living bone is not necessary for the permanent life of grafts.

9. Finally, periosteum transplanted into the soft parts may produce new bone.

Indications for Bone Grafting (modified from Murphy, *J. A. M. A.*, vol. lviii, 1912).—1. To correct deformities resulting from defects of development, as aplastic extremital bones—radius, ulna, humerus, tibia, fibula and femur, and congenital and acquired saddle-nose, aplastic mandible, spina bifida, etc.

2. To produce union in ununited fractures. This is the best treatment and much superior to Lane's plate.

3. To replace bone removed by destructive infections, osteomyelitis, tuberculosis, lues, etc., *e.g.*, spina ventosa.

4. To restore or supplant fragments dislodged or destroyed by fractures, as the head of the humerus, head of femur, shaft of tibia, etc.

5. To replace bone removed for non-malignant neoplasms, cysts, myeloma, osteitis fibrosa, adamantinoma of jaw.

6. To replace bone removed for encapsulated malignant disease, as giant cell and chondrosarcoma, etc.

7. To immobilize joints, as, for example, those with too

great laxness or imperfect muscular control, resulting from infantile paralysis or Charcot joint, and for the cure of tuberculosis of joints, as in bone grafting for tuberculous spine (Albee's operation).

General Principles to be Observed in Bone Transplantations.—No cavity which is septic should be filled with transplanted bone as the graft will die and slough out. All wounds should be perfectly healed before transplantation is attempted.

Most scrupulous asepsis is an absolute essential. No graft should be handled by the operator. It should be grasped by instruments and thus inserted in its new bed.

The living graft should be transplanted always with periosteum on it. This is most important.

The graft should be taken living from the same individual who is to receive the transplant. If this be not possible, then it should be taken from as near a relative as possible. Animal bone should not be used, if it is possible to avoid it, because it will be absorbed owing to the changed serological relations. If taken from another individual, the grafting should not be done until syphilis is ruled out by a Wassermann reaction.

When the head of the humerus or femur is fractured and dislocated and the joint is opened, then the head should be replaced and attached to the freshened lower fractured surface, even though the head be dead, provided it is still aseptic.

All foreign non-absorbable material, wires, nails, celluloid, rubber, etc., should be avoided as implants unless under very exceptional conditions. Encircling wires will erode the bone and a fracture may result. These non-absorbable foreign bodies tend to irritate, if not invite suppuration, and often produce sinuses which will usually require their removal to cure the sinuses. Chromic gut should be used to fix the grafts in position, avoiding nails and wires for the above reason, and living bone grafts should be taken from the same patient who is to receive the graft, if possible.

A graft increases in size according to the demands put upon it by the organism. Experience has taught that it is not necessary to fill up completely with a living graft a defect. A much

smaller living transplant with its periosteum may be used which will increase to the size necessary. This statement is fixed and settled by many transplantations.

After transplantation absolute immobilization is essential for success. This should be maintained for at least five months, longer if roentgenograms show its necessity.

An Esmarch tourniquet had best not be employed, since it predisposes to subsequent oozing, and blood would be effused about the graft, whose nutrition is thus injured and the tendency to suppuration is increased.

Methods of Bone Transplantation (modified from Binnie).—1, Transplantation of small bone chips with as much periosteum as possible; 2, transplantation of free, non-pedunculated, large fragments, always with periosteum covering at least one side; 3, transplantation with pedunculated bone flaps, the pedicle being either permanent or temporary and the bone taken either from the same bone which is to be grafted or from a neighboring bone; 4, transplantation combined with arthroplasty, implantation of a part of the length and the whole thickness of the shaft of a bone with one articular end; 5, transplantation of periosteal flaps (Codivilla's operation); 6, transplantation for congenital absence of tibia; 7, transplantation of dead bone, either decalcified bone chips or large fragments; 8, transplantation of absorbable or non-absorbable foreign material; 9, transplantation of joints.

1. *Transplantation of small bone chips.* The following is an illustrative case:

> Macewen in his book mentions the case of a boy, the whole of whose diaphysis he was compelled to remove for necrosis. There was no subsequent osseous deposition. Fifteen months later he was readmitted with the request by the parents that the boy's useless arm be removed. Two wedges of bone were excised from another patient of six years of age afflicted with anterior curves. These were cut into minute fragments, quite irrespective of the periosteum, and were then deposited into the muscular sulcus in the boy's arm. There was no pus formation. Two months later a portion of new bone, an inch in length and three-quarters of an inch in thickness, was found firmly attached to the upper fragment of the humerus. Here all the grafts proliferated, grew to one another, and also to the extremity of the proximal portion. Two other wedges of bone of larger

size than the first were similarly dealt with and inserted two months subsequently to the first graft, and a third couple were placed in position five months after the first. These all fused together and to the condyles of the humerus, filled the gap in the arm to the extent of four and a quarter inches. It is now 30 years since the humeral shaft was rebuilt, and during all that period the man has depended upon his physical exertions for the earning of his living. He worked as a joiner for many years, and is now an engineer's pattern-maker.

Macewen also relates the following experiment. This experiment I have myself duplicated with precisely the same result in several dogs but not always.

The greater part of the shaft of the radius with its periosteum was removed. The shaft of the bone removed, destitute of its periosteum, was then cut into very fine shavings and these shavings were placed between the muscles, which bulged into the gap left in the bone by the removal of the shaft. The neighboring muscles were then attached over the bone shavings in order to keep the shavings in position, and especially to prevent their being extruded from the wound. Examination of the specimen obtained seven weeks after operation showed that the continuity of the shaft was entirely restored. There was a marked increase in the diameter of the shaft opposite the part where the shavings had been inserted. All the component parts had become fused by osseous tissue into one another and both ends of the shaft.

The method of transplanting small chips does not seem to have as great an advantage as transplanting a large single fragment with periosteum for the reason that small chips are less liable to have periosteum on them than large ones, and consequently some of them will die and become absorbed. This I have noticed also by experiment. The teaching seems clear that in simple, comminuted fractures, one should not remove loose fragments, particularly if there be any periosteum on them. They should be replaced, if kept aseptic.

Technic.—Let us suppose the grafting is for ununited fracture, expose the ends of the fragment, remove all fibrous tissue between them and freshen the ends by sawing them off. The favorite bones from which to get the grafts are the tibia, clavicle, rib and upper third of ulna. Tibia is probably the best. Remove from it, as described under the next section, a length of bone sufficient to bridge the defect, with periosteum on one of its sides. With chisel divide this piece of bone into

small fragments with periosteum on each fragment if possible. Fill the defect to be closed by these fragments. Close the wound without drainage and immobilize.

2. *Transplantation of non-pedunculated large fragments, but always with their periosteum.* Success is assured if the periosteum be on the grafts, if asepsis be attained.

The following case is illustrative of free large bone grafts and how important it is to have periosteum on grafts. Two transplantations were performed, the first time, following Macewen's teaching, without periosteum. The graft was absorbed. The second time periosteum was on the graft and the result was perfect.

CASE I.—This is an exceedingly interesting case of non-union in a birth fracture of both bones of the leg in a child 17 months old. The non-union I attribute to insufficient immobilization of the leg. I cut down upon the fracture and after freshening the pointed extremities of the fragments, there resulted a defect of an inch and a half in the tibia, which made transplantation of bone necessary. A graft (Fig. 6) from the opposite tibia was chiselled out with its periosteum. The periosteum was then deliberately peeled off the graft with the object of confirming Macewen's view of its unimportance. One end of the graft was pointed and it was wedged into the medullary cavity of the upper fragment, and the lower side of the transplant was spliced to the side of the lower fragment with chromic gut. The subsequent union of the wound was by first intention. The next picture shown (Fig. 7) was taken six months after the grafting. It was very disappointing to see the tibial graft gradually melt away in the tissues, so that, after six months, it was not more than one-quarter its original size. Since union was by first intention, there seems no way of accounting for the death of the graft save on the basis of a lack of periosteum, or of a deficient blood supply, or both.

Six months after the previous grafting operation, I transplanted five inches of the opposite healthy fibula into the medullary cavities of the fragments, as is seen in the picture, Fig. 8. It was transplanted with the periosteum covering its entire circumference and this was not split in the slightest. The result shows that this splitting of the periosteum on a graft is entirely unnecessary

FIG. 6.

Human transplantation. Graft without periosteum into tibial defect.

FIG. 7.

Same patient after six months. Graft is disappearing.

FIG. 8.

Same patient after second transplantation. Into the medullary cavities of the tibial extremities was inserted a section from the same patient's opposite fibula with periosteum on all sides.

FIG. 9.

Same patient six months after the second transplantation. The graft has increased enormously in size, but it has been fractured, with the production of an enormous callus. The fracture is healing nicely. The wire is eroding the graft.

FIG. 10.

Same patient four months after the removal of wire. Fracture has healed and the lower part of the graft is developing.

and accomplishes nothing. Below a wire encircling suture was used to hold the graft in place.

Fig. 9 was taken six months after the transplantation. To my mind it seems to imply the necessity of revising Dr. Murphy's conclusion that a graft is not osteogenetic in itself. A fracture has taken place in the lower third of the transplant, due to the fact that the child kicked off the splint one night. We see that the upper portion of this fracture of the graft itself is consolidating nicely under an enormous callus. If we accept Dr. Murphy's conclusion, we must believe that all this callus came through the graft from the contacting old bone of the neighboring stumps. I do not accept this view for a moment, but believe that the callus arose either from the periosteum or from the bone of the graft itself. Along the outer surface of the graft we see at least a quarter of an inch of new bone evenly distributed. Were this new bone formed from the contacting ends of the old bone of the stumps, it seems to me that it would shade off, becoming less the further we went from the old bone. As a matter of fact, the greatest amount of new bone is at the fracture spot in the graft, which is at some distance from either contacting extremity of old bone. The lower fragment below the fracture, due to the inhibitory influence of the wire, has scarcely developed at all and it is being eroded by the wire. On June 9, 1913, I removed this wire, when the lower fragment started immediately to develop. Fig. 10 was taken four months after the wire was removed. The fracture is healed and the callus has disappeared. Consolidation is progressing nicely between the lower end of the lower fragment and the upper end of the lower shaft.

Technic.—Let us take, for example, an ununited fracture. Bone grafting is the operation of choice in such a condition. Expose the ends of the fragments, remove all fibrous tissue from between them and freshen the ends by sawing off sections. The bone graft may be chosen from the tibia, rib, upper third of ulna, clavicle or crest of ilium. If the rib be chosen, periosteum should be taken covering half its surface, so as to avoid opening the pleura. The tibia is the easiest and the most frequently employed bone from which to get the graft. A curved incision through the skin is made beginning at its

anterior border with the convexity nearly at the posterior border, ending below at the anterior border again. The flap of skin is reflected off the periosteum beneath. A wide thin carpenter's chisel is as good an instrument as any to make the graft and there is no need of a more complicated circular motor saw. Measure the length of defect to be filled in and add to this sufficient length to dovetail each end into the corresponding medullary cavity of the fractured ends. With the chisel make transverse cuts at the anterior border of the tibia at each end of the part to be transplanted, one-half or three-quarters of an inch deep, the transplant being about as thick as one's forefinger. On the internal surface join the posterior end of each transverse cut by a longitudinal groove which is made by successive light blows of the mallet on the chisel directed outward, which is moved along after each blow. This is to prevent splintering of the graft. Proceed deeper, the chisel being moved along the groove after each blow. By a longitudinal incision divide the tibialis anticus from the external surface of the tibia without injury to the periosteum, which is longitudinally incised at a distance the same as on the internal surface. Join the posterior ends of the transverse incisions in the bone by a longitudinal groove made on the external surface, the chisel being directed inward through the incision in the periosteum. Proceed deeper until the chisel enters the medullary cavity, then go to the opposite groove and carry this likewise into the medullary cavity. The graft is lifted out by an instrument and is never touched by the gloved hand. The graft should be placed into the defect made for it just as quickly as possible that its cells may not die from lack of nourishment. It should not be placed in salt solution as this washes away the little blood that is left on the graft to nourish its cells. Murphy's method is to enlarge the medullary cavities of the fragments with a reamer or burr for a distance sufficient to form a good firm bed for the graft. An equally good method is to make longitudinal furrows opposite to each other on the stumps, large enough to receive the graft. Drill holes are made through the fragments and graft and chromic gut sutures

are inserted through them and tied. Murphy prevents the graft from riding up the medullary cavity by inserting a nail through the fragments and graft, but it seems wise not to use any foreign body which may later irritate. It is not necessary for apposition to be maintained between the ends of the fragments of the fractured bone though this is desirable. In this way can be overcome the shortening of the extremity. The graft has periosteum on two of its surfaces and medullary tissue on the other and will positively live if asepsis be attained. Both wounds are closed without drainage and the fractured limb is immobilized.

BITTNER resected the lower half of the shaft of the tibia for sarcoma, leaving the lower epiphysis. He filled the gap by splitting longitudinally the remaining half of the shaft up into the tuberosity, turning the segment down and fixing it in place. Only 1.5 cm. shortening resulted and the leg was strong and useful.

SIEVERS (*Beitrage zur kl. Chir.*, vol. 85, Heft 1) reports having excised the mid-phalanx of the ring finger with its periosteum for sarcoma. He filled this defect by excising the first phalanx of the fourth left toe and transplanting this into the finger defect. The toe defect was filled by a graft from the tibia.

WITZEL (*Deut. Zeit. f. Chir.*, Bd. 121, H. 1, p. 180) reports two successful cases in which he substituted a part of the clavicle, resected for sarcoma, by the spine of the scapula.

PELS-LEUSDEN (*Chir. Operationslehre*, p. 222) says that spina ventosa should be treated by excision of the diaphysis with its periosteum and the defect should be filled in with a graft taken from the tibia with its periosteum.

3. *Transplantation with pedunculated bone flaps, either temporary or permanent.* This method is mentioned for the sake of completeness. It is a great question whether it has any advantages over free bone transplants which are uniformly successful if periosteum be on the graft, and if asepsis be attained. Certainly the conditions will be rare in which pedunculated bone flaps are required.

A. Ollier's operation *par renversement.* Expose the ends of the bone and excise the fibrous tissue between them. With a fine saw cut from one fragment a thin triangular slice of bone after freshening the opposite end. The slice of bone is hinged by the periosteum at the other end of the saw line. The triangular wedge of bone is now turned downward and its apex is sutured with chromic gut to the raw bone surface below, or it can be

pushed into the medulla. As much as two inches of bone may be replaced by this method. The periosteum is the permanent pedicle.

B. Ollier's operation *par glissement.* Freshen the end of each fragment and remove the fibrous tissue. From the upper end cut a triangular piece of bone with periosteum on it, but do not separate this portion of bone from its connections with the soft parts. Slide this piece of bone downward and suture it to the end of the lower fragment.

C. Ollier's operation of implantation. This is only suitable when one of two parallel bones is the site of a defect. The sides of the ends of the fragments are obliquely vivified opposite the bone from which the transplant is to be taken. These surfaces make two sides of a triangle. From the opposite healthy bone a triangular piece of bone is cut which retains its connections with the soft parts. The graft is turned and implanted into the defect, where it is sutured.

D. Muller's two operations. The first is made by turning the flap which consists of skin, periosteum and bone, the pedicle being permanent. The ends of the fragments are exposed by a vertical incision which projects upward and downward, covering half an inch of the surfaces of each fragment. Remove all scar tissue interposed and freshen the ends and sides of the bone with a chisel. On the surface of the upper fragment outline a tongue-shaped flap, cutting through the periosteum with the knife. The pedicle consisting of skin is off to one side. With a chisel introduced through the upper flap incision cut a slice of bone corresponding to the skin incision. Rotate this flap so that it bridges the osseous defect and fasten the bone in the flap to the raw surfaces of the fragments with chromic gut. Undermine the edges of the upper defect so as to bring them together, or close it by Thiersch's grafts.

The second method by Muller is one in which the twisting of the pedicle is avoided. Make a V-shaped incision, the open part of the V being about two inches below the end of the lower fragment and projecting upward the same distance in front of the upper fragment. Carry the incision through the periosteum below and raise a slice of bone with the chisel from in front of the lower fragment. Elevate the flap, expose the defect between the fragments, remove the fibrous tissue, vivify with the chisel the ends of the bones and the front of the upper fragment. Carry the incision upward through the skin only on the surface of the upper fragment and loosen this part of the flap. Draw the flaps up until the bone in the flap bridges the defect between the upper and lower fragments. Suture the bone in this position. Carry the incision upward until the redundant portion of the upper part of the flap can thus be smoothed out. Undermine the edges of the lower defect and bring them together or Thiersch graft them. This operation has given Muller, Sprengel, von Eiselsberg splendid results.

These operations are not of frequent applicability. If the defect be over 4 or 5 cm. they will be impossible. An objection which strikes me is the increased liability to infection, owing

to the Thiersch grafts, or to tension of the sides of the defect, as well as to the small raw surfaces which are liable to be left at the sides.

Vulpius has cut a transplant from one of the fragments with a pedicle solely of periosteum, situated very near the pseudarthrosis. He then turns the graft 190° around on this pedicle and fixes it to the other fragment. A musculo-aponeurotic flap has been used, obtaining the transplant from a neighboring bone. Codivilla has transplanted a graft taken from the iliac crest upon the femur, twisted about a pedicle, taken from the gluteus maximus; and upon the humerus a graft taken from the external border of the scapula, nourished by a part of the external rotators of the shoulder. Bardenheuer in two cases has transplanted the spine of the scapula upon a pseudarthrosis of the humerus. These procedures seem complicated and unnecessary.

Hahn or Huntington's operation. This is suited to patients in whom there has been an extensive loss of tibia but the fibula remains intact. Through an appropriate incision (curved, across the leg at the level of the upper fragment), expose the under surface of the upper fragment and vivify it. Cut the fibula off at this level and insert its end into the under surface of the tibial upper fragment where it is fixed. Six months later, a second operation is done. Expose and vivify the upper surface of the lower fragment of the tibia. Divide the fibula at about the same level and unite its lower end to the fresh surface of the tibia. In some cases both operations have been done at one sitting.

A graft increases in size according to the demands put upon it. This is seen in the case of the above transplanted fibula which eventually increased in size to that of the tibia.

Bardenheuer in a defect in humerus made a tongue flap on chest. Subperiosteally resected a rib which was left attached to flap which was reflected into defect. Division of the bridges in two months. Good union.

4. *Transplantation combined with arthroplasty.* Rovsing excised a sarcoma from the upper end of the humerus and implanted a segment of the fibula. He excised the diseased bone from the humerus together with its periosteum and muscular attachments. He then exposed the upper end of the fibula through a longitudinal incision, retracting out of the way the uninjured external popliteal nerve. The superior tibiofibula articulation was opened and the ligaments divided. The fibula was then mobilized for a distance of 3 cm. longer than the segment of humerus which was removed, by cutting the muscles arising from it, leaving a muscular sheath, about 1 cm. thick, attached to it. The lower end of the fibula fragment was sharpened with a chisel and this was forced into the medullary cavity of the remaining diaphysis of the humerus. Sutured the remains of the articular capsule of the shoulder-joint about the upper end of the fibula and the soft parts of the arm to the muscular tissue left attached to the transplanted fibula.

Walther and also De Gouvea each resected the inferior extremity of the radius for sarcoma. Into the resulting defects each transplanted the

superior extremity of the fibula with its periosteum, the head of which was placed in contact with the carpus. Intermedullary fixation of upper end of graft. Result in each case was splendid.

5. *Transplantation of periosteal flaps* (Codivilla's operation). Codivilla, after freshening the ends of the bone, unites them with a wire suture and envelops this suture with a free, detached flap of periosteum taken from any convenient bone, taking pains to shave off with the periosteum a thin shell of bone, but Brade used the periosteum alone and obtained a good result. It would seem to the author better to use an absorbable suture such as large chromic gut rather than wire between the bones. The internal surface of the tibia is a good location from which to get the periosteum. A thin slice of bone should be taken with the periosteum and attached to it.

6. *Transplantation for congenital absence of tibia.* Halsted Myers (*Med. Record,* July 15, 1905) operated as follows: The entire tibia was wanting but the fibula was intact and in its proper position. The outer half of the joint was incised, opening the articulation between the fibula and femur. The patella ligament, thin and strong, was found to be inserted into the inner side of the fibula well below the head. The external lateral ligament was divided. The head of the fibula was drawn down and into a position between the condyles. The patella ligament was shortened and attached to the anterior surface of the fibula. The articular capsule was sutured so as to aid in holding the head of the fibula in its new position. The wound at the knee was closed, after which the ankle was opened by a transverse incision, the external malleolus was cut off and the raw end of the fibula was planted on to the upper surface of the astragalus which was freshened by the chisel to receive it. The bones were sutured together. Immobilization. A year after the operation, the patient could flex his leg to 90°, almost fully extend it, and walked about all day.

7. *Transplantation of dead bone, either decalcified bone chips or large fragments: Senn's decalcified bone chips. Preparation of the chips.* Remove all periosteum and medullary tissue from the fresh tibia or femur of the ox, divide into longitudinal strips about ⅛ of an inch wide and immerse in a relatively large quantity of 10 per cent. watery solution of hydrochloric acid which should be renewed daily, for from one to two weeks; then wash thoroughly in water or a weak solution of caustic potash, cut into small chips, soak for forty-eight hours in 1 to 1000 mercuric bichloride solution, remove and store in a saturated solution of iodoform in ether. When about to be used, wrap in aseptic gauze, dissolve out the excess of ether and iodoform with alcohol and put in 1 to 2000 mercuric chloride solution until required, when careful drying with iodoform gauze should precede their implantation.

Technic.—Fill the cavity completely or the defect between the ends of bone whose extremities have been previously freshened with the chips and allow blood to fill up the interstices between the chips. It is claimed that the bone chips strengthen the framework of blood-clot into which the healthy granulation tissue penetrates, while the iodoform disseminates through the blood clot which thus inhibits bacterial activity (?).

Transplantation of large fragments of dead bone. This method has given some successes.

Kausch, after removing the upper end of the tibia for sarcoma, implanted a corresponding portion of the tibia obtained some days previously in the course of an amputation. The implant was deprived of its periosteum and marrow, was carefully boiled and soaked in ether to remove its fat. An amputation, nine months after the transplantation, for recurrence of the sarcoma, showed the implant firmly united both to the femur and tibia and enveloped in a new formed periosteum. Kuttner excised the upper third of the femur for sarcoma and at once implanted a similar portion of the femur, obtained from a man who died of coma, due to tumor of the brain. The upper end of the femur along with its head was removed under aseptic precautions, eleven hours after death, and was preserved for twenty-four hours in salt solution, to which some chloroform had been added. Six weeks later the result was promising. Brewer, of New York, removed the entire lower third of the radius with its periosteum for sarcoma. A few days later a suicide was brought into the hospital, where he died. The corresponding radius was dissected out, of just sufficient length to fill the defect. This bone was then boiled and kept for several days in sterile salt solution, when the original wound was reopened and the graft was implanted. The soft parts were sutured around it. Union was by primary intention. Several months afterward the transplant showed a moth-eaten appearance, as though it were absorbing. One year later the man had a very useful forearm and hand. At the junction of the graft with the old shaft there was some bowing but union was solid. Roentgenograms showed that the old graft had largely become absorbed but that it had been replaced by new firm bone. The result was very satisfactory.

How many non-successes have followed this method, no one can say. Surgeons are not inclined to publish their non-successes, hence the investigator can scarcely arrive at an unprejudiced judgment of the true value of any particular method.

A better method for the above would seem to be as follows: Walther (*Bull. et mem. de la Soc. de Paris*, vol. 37, No. 20) resected the inferior extremity of the radius for sarcoma similar to Brewer's case above. Into the defect he transplanted the superior extremity of the fibula with its periosteum, the head of which was applied on the carpus. Intermedullary fixation of upper end of graft. Result was fine.

De Gouvea (*La Presse Medicale*, July 17, 1912) performed an exactly similar operation to the preceding with a successful result.

8. *Transplantation of absorbable or non-absorbable foreign material.* *A.* Non-absorbable material. Murphy and numerous German surgeons have implanted into a defect in the lower jaw made for the removal of malignant tumors, a silver wire model with a metal head of normal size and shape of the mandible. In Murphy's case suppuration occurred around the frame-work, since it communicated with the mouth, and a profuse discharge was present for six weeks, when it ceased entirely. The sinus healed and the frame-work became completely imbedded. Three years later there was no sinus present and the function was good. Because of its vascularity

and resistance to infection, the mouth and face offer the best field for its use. In other parts of the body, sinuses may form which will persist, requiring the removal of the foreign material.

B. Absorbable foreign materials such as ivory, magnesium plates, tubes, or columns have their uses in but a few situations in the body and can usually to advantage be replaced by living bone grafts taken from the same patient who is to be grafted.

Primrose implanted an ivory peg of suitable size and shape into a phalanx removed for a central enchondroma. Fourteen weeks later a roentgenogram showed the peg partially absorbed but surrounded by a satisfactory amount of bone. Possibly a better method would be to remove a phalanx from the patient's toe with its periosteum and transplant that, or else a small piece from the tibial crest with its periosteum.

9. *Transplantation of joints.* In bony anchylosis of the elbow, Buchmann (*Zentralbl. für Chir.*, 1908, No. 19) has devised what may be a valuable procedure. In two cases he transplanted the first metatarsophalangeal articulation into the elbow-joint. His procedure is as follows: A posterior longitudinal incision is made down to the triceps tendon and the olecranon. Divide all the soft parts longitudinally along the outer side of the olecranon. With an elevator, separate and push inward the triceps tendon, remnants of capsule and periosteum. Divide the olecranon at the level of the joint and the lateral remnants of the capsule. Divide the bony union between the humerus, radius and ulna. Flex the elbow and cut out from the trochlea a niche, wider in front than behind and narrower above than below. Remove a very thin slice from the lower end of the humerus. Separate the brachialis anticus from its insertion into the coronoid process. Cut a quadrangular niche in the ulnar epiphysis. Remove the head of the radius and separate the radius from the ulna. Excise the first metatarsophalangeal articulation without opening the joint itself. Remove with the joint sufficient of the metatarsus and phalanx to fit into the niches cut in the humerus and ulna. Implant the excised joint into the wound at the elbow in such a manner that its plantar surface faces backward. Fit the ends of the metatarsus and the phalanx into the corresponding niches cut in the humerus and ulna. Close the wound in the elbow, sewing all divided tissues back into their original normal positions. Immobilize in the extended position.

Lexer (*Archiv. f. kl. Chir.*, vol. 86, p. 852), in 1908, described two cases in which he transplanted the entire knee-joint. The difficulty in obtaining a knee-joint to transplant will undoubtedly prevent the surgeon from frequently imitating this procedure. Lexer warns against obtaining a knee-joint from a cadaver since, in one of his cases, there was so great a formation of connective tissue, that the graft had to be removed on account of lack of motion. The graft will have to be obtained from a freshly amputated extremity, removed for senile gangrene (without phlegmon) or for paralysis. Those interested should consult the original article.

AUTOGENOUS BONE GRAFTING FOR FRACTURE OF THE PATELLA.

BY JOHN ROGERS, M.D.,

OF NEW YORK,

Surgeon to Bellevue and St. Francis Hospitals.

THE usual method of treatment for these injuries consists in exposing the fragments and uniting them by absorbable or non-absorbable sutures. The advantages of absorbable or non-absorbable suture material seem still debatable, with opinion more in favor of chromicized catgut or kangaroo tendon than of bronze or silver wire.

The degree of separability of the fragments depends upon the amount of laceration of the capsule and fibrous tissue in continuity with the line of fracture. Unless these lacerations are repaired when the fragments are sutured, muscular contraction may interfere with bony union no matter what material is used to hold the bones in apposition, and no matter how carefully clots and fibrous fragments are removed from between the bones.

A not uncommon accident after operation in spite of every precaution, is a refracture from apparently insignificant violence. Fibrous union with separation of the fragments and greater or less disability in the injured extremity is probably a more frequent bad result.

To remedy either of these conditions it is suggested that an autogenous bone graft be taken from the crest of the patient's tibia and implanted on the front of the patella to bridge the line of fracture. Similar treatment is applicable to certain fractures of the olecranon.

Operation to Relieve Disabling Fibrous Union of the Patella, or to Cure "Refracture" of the Patella.—Make a U-shaped flap, with the apex of the convexity over the ligamentum patellæ and the extremities over the condyles of the femur, suture the lateral rents in the fibrous capsule. Denude

the anterior surface of the patella fragments of periosteum over an area about one inch square on each side of the line of fracture. Expose the crest of the tibia and chisel off from its inner surface a quadrilateral plate 1½ inches long by ¾ inch wide by ⅛ inch thick. Leave its periosteum undetached.

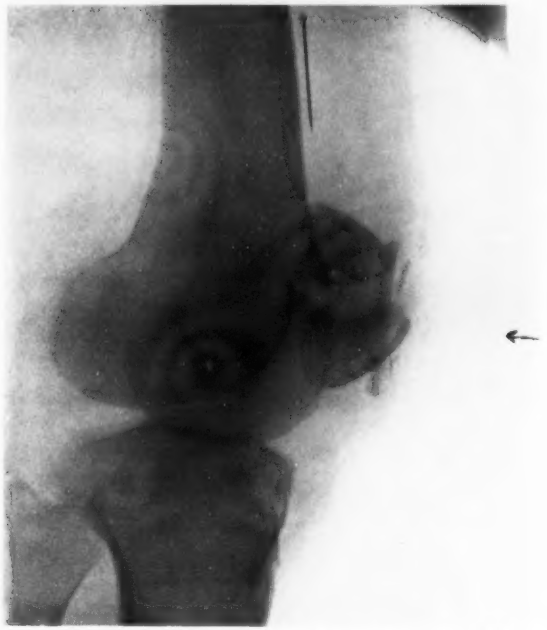
Place this with its raw surface in apposition with the denuded area in front of the patella. Unite the fragments by a figure-eight suture of chromicized catgut or kangaroo tendon, which grasps the ligamentum patellæ and quadriceps tendon immediately below and above the broken bone and crosses in front of the transplant. The periosteum, which was previously turned back from the patella, is next drawn up to, or over, the transplant with a couple of catgut sutures. The skin incisions are closed by a subcuticular catgut stitch, and the limb enclosed in a plaster-of-Paris case splint for four or five weeks.

CASE I.—*"Refracture" of the patella.* Miss A. L., age thirty-four, fell down stairs and sustained a fracture of the right patella on November 1, 1912. I sutured this in the usual way in St. Francis Hospital on November 4, 1912. The splint was worn eight weeks and there was an apparently perfect result.

On February 10, 1913, she slipped on some ice and, without falling, felt something snap. She then walked to the Hospital and the patella was found to be fractured exactly as before. On February 17, under ether the operation described above was carried out. The suture material to retain the bones in position was chromicized catgut. The case splint was worn subsequently for only four weeks. Complete flexion of the joint was possible at the end of about nine weeks. The radiographs show the transplant at the end of three weeks, six weeks and thirty-two weeks (Figs. 1, 2 and 3).

CASE II.—*Ununited fracture of the patella.* Mr. L. S. age forty-four, sustained a fracture of the left patella (by muscular violence) on January 22, 1913. It was treated only by strapping and immobilization for six weeks. He then entered Bellevue Hospital for relief of the weakness in the leg. He was unable to raise the foot from the bed while in a horizontal position. There seemed to be a weak band of fibrous tissue between the fragments which were one inch apart.

Fig. 1.



Case I. A. L. Refracture of patella. This occurred February 10, 1913, and the bone graft was inserted February 17. Radiograph taken March 15, 1913.

Fig. 2.

Case I. A. L. Taken April 5, 1913.

FIG. 3.

CASE I. A. L. Taken October 6, 1913.

FIG. 4.

CASE II. L. S. Ununited fracture of patella. This shows the position of the fragments six weeks after the injury, on admission to Bellevue Hospital.

FIG. 5.

CASE II. L. S. Showing the autogenous bone graft in position August 1, nineteen weeks after its insertion. There is a perfect functional result.

On March 19, 1913, under ether, the operation described above was carried out. The upper fragment was bound close to the femur by much fibrous tissue, which required very free division before the loosened bone could be brought even near to the lower fragment. Complete contact could not be secured. The suture material to retain the bones in position was chromicized catgut. A case splint of plaster of Paris was worn for six weeks. The result has been perfect restoration of function. The radiographs (Figs. 4 and 5) show the transplant nineteen weeks after its insertion.

THE TREATMENT OF UNUNITED FRACTURES OF THE TIBIA BY THE TRANSPLANTATION OF BONE.

BY M. S. HENDERSON, M.B. (Tor.),

OF ROCHESTER, MINN.

Mayo Clinic.

UNUNITED fractures of the tibia are relatively common, especially in the middle and lower third of the bone. It is true that we do not see cases of such long duration as those of ununited fractures of the humerus which may be of five and ten years' standing. In one case, recently operated on in the Mayo Clinic, the humerus had been ununited for fourteen years. An arm thus partially disabled is infinitely more useful than an artificial arm and is not, therefore, sacrificed. On the other hand, an ununited fracture of the tibia necessitates the use of crutches or, for a laboring man, complete cessation of work. In such cases an artificial limb is more useful and therefore the legs are sometimes amputated.

The ingenuity of the surgeon has been greatly tried in the treatment of these cases. Many procedures have been advocated, prominent among which, of late years, have been the silver wire and the metal plate. The plate is best suited for certain recent fractures in the tibia in which apposition of the fragments cannot be maintained in any other manner. A perfect anatomic reposition of the fragments is not essential for excellent function. A little displacement is permissible if the axis of the line of weight-bearing in each fragment is parallel, but weight-bearing through an angle is bad, particularly if the fracture be near the joint.

Transplantation of bone into the tibia gives excellent results and the method herein described is so simple and reasonable that it must inevitably supersede the use of the plate or other mechanical devices in the majority of cases.[1]

[1] In describing this method the author makes no claim for originality. Others have used practically the same procedures. Buchanan published an article and reported a case (*International Journal of Surgery*, October, 1912).

It was noted in these cases that the fibula when fractured had united. If these patients have been previously operated on or if there is much laceration of the skin at the time of the accident, the difficulties in operating are greater. This scar which is closely adherent to the bone, poorly nourished and deprived of subcutaneous tissue, is liable to slough after being lifted up, a complication which occurred in two of our cases. No infection followed but careful dressings were necessary after the slough had separated until healthy granulations appeared.

In the treatment of cases of ununited fractures, enough bone for transplantation can be obtained from the same leg, thereby greatly shortening the patient's stay in bed. The transplanted bone will live if the following conditions are fulfilled: (1) The observation of asepsis; (2) if bone be obtained from the same individual; (3) securing a free supply of blood in the new habitat; (4) maintaining a reasonable amount of bony contact.

This procedure is not recommended for the infected case, although some surgeons have transplanted bone with infection present and obtained good results. When infection is present the bone to be transplanted should first be removed from the other leg and all work completed on this leg before the infected member is touched.

The question here arises: When are we to transplant bone for fractures which have not united? Robert Jones[2] speaks of the condition as "delayed union." This is a better nomenclature than "non-union" since it is probable that all of these fractures would unite in time. However, with the present-day advantages of surgery an operation for this condition may be advised, thereby saving time for the individual and an earlier return to his wage-earning capacity.

There can be no definite period assigned for transplanting bone in these cases of delayed union. Many factors should be considered, but the chief aim of the surgeon is to restore the individual to his duties at the earliest possible period.

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[2] *Amer. Jour. Orthop. Surg.*, October, 1913.

There is generally but little deformity in the fractured tibia and good alignment and position may usually be maintained by the aid of plaster-of-Paris casts or splints. It is difficult to understand why union should not take place in these cases. The type of cases under consideration in this paper does not include the so-called Pott's fracture. Here it is true that the tibia enters into the question, but non-union rarely results and these patients usually seek relief because of faulty alignment which so intimately involves the ankle-joint as to demand correction.

The 9 cases herewith reported were all healthy young males —one a boy 8 years of age. Syphilis was present in but one, and this was contracted after the leg had been broken one year. In the series of 9 cases, 6 were simple fractures and 3 were compound fractures. One of the latter had become infected. The other two, although the bones protruded at the time of the accident, had healed without any signs of infection. It does not seem probable that infection had any bearing on the delay in union.

The bone in these cases is especially adapted to transplantation since it is easily accessible, the operative field being just beneath the skin. The transplant will not have to hold the alignment because this can readily be done by external means. The fibula, which is intact or firmly united, maintains the length of the limb and no slipping-by of the fragments is likely to occur. The transplanted bone may be placed in a normal field; it is not necessary to put it in the medullary cavity. A gutter is chiselled or sawed in the fragments down to the medulla, thus allowing the transplant to have a natural bed to rest in. If a piece of cortical bone is used as a medullary plug it acts merely as a foreign body. It is, however, an absorbable foreign body and gradually disappears. During its absorption, osteogenesis is promoted, which leads to union. In operating on cases of ununited fractures of the humerus, 25 years ago, C. H. Mayo used an ordinary cataract bone knife-handle to make an intramedullary plug. He fastened linen sutures to its centre, leaving long ends, and brought these out through

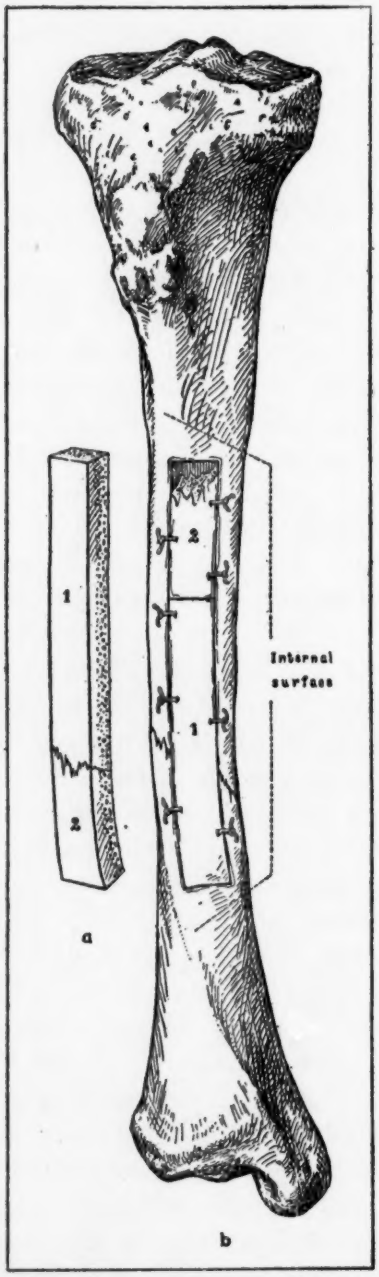
the wound. These sutures were tracted every day, thus causing a little motion of the plug. In this way, a mild irritative osteitis was kept up which was conducive to osteogenesis and the formation of callus. This ivory plug usually healed in, but occasionally disintegrated and came out in small pieces.

If transplants are taken from the opposite tibia, patients must be kept off their feet for a month or more. It is much simpler to take the bone from the same tibia, either above or below the fracture and get our patients up within a few days. The bone should preferably be taken from the flat internal surface of the tibia rather than from the crest which is dense, strong, and being the apex of a triangle, serves a most important weight-bearing function. A piece of bone removed from here down to the medullary cavity weakens the bone out of all proportion to the size of the piece removed. The bone on the internal surface is not so dense and is also more vascular and a large piece may be removed here without greatly weakening the bone. All the layers, *i.e.*, periosteum, cortex and medullary lining, should be included in the transplant.

In studying these pieces of transplanted bone by a series of X-ray pictures after their implantation, it is apparent that they live and functionate without being replaced by new bone. In the tibia, by forming a gutter down to the medullary cavity, the transplant can be placed so that periosteum meets periosteum, cortex meets cortex and medullary lining meets medullary lining, thus obtaining an anatomic approximation favorable to rapid healing.

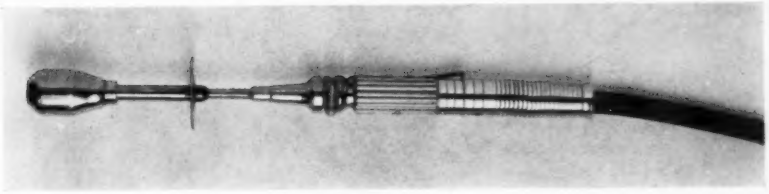
The technic of the operation, as followed in our more recent cases, is simple and may best be shown by the diagram (Fig. 1). Either by the aid of the chisel or the motor-propelled circular saw (Fig. 2), a piece of bone is removed from the internal flat surface of the tibia. The bone should be of sufficient length to make a substantial bridge, usually 2 or 3 inches long and about ½ inch in breadth, and should include all the layers. This is taken from the longer fragment. A piece the same width in the same line is then removed from the smaller fragment. This is saved. The larger piece of trans-

FIG. 1.

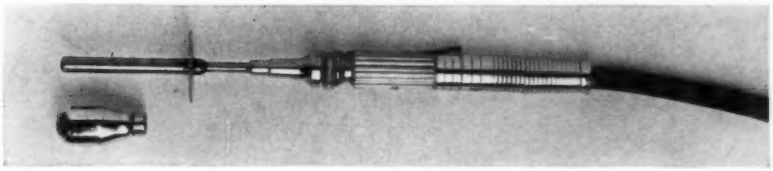


1*a* shows diagram of transplant removed from the long fragment; 2*a* shows transplant removed from the short fragment. 1*b* shows inversion of long transplant to bridge fracture; 2*b* shows short transplant inserted to fill gap left by removal of transplant from long fragment. Catgut sutures in periosteum of graft and shaft.

FIG. 2.



a



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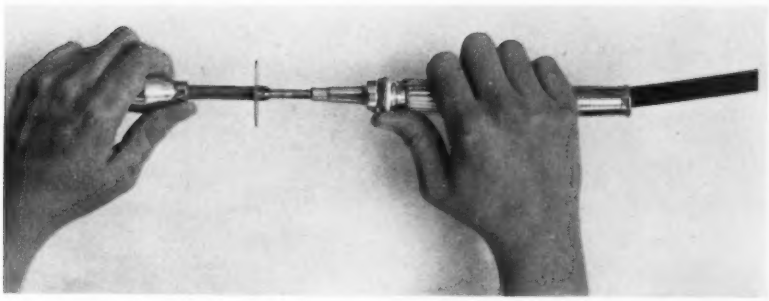
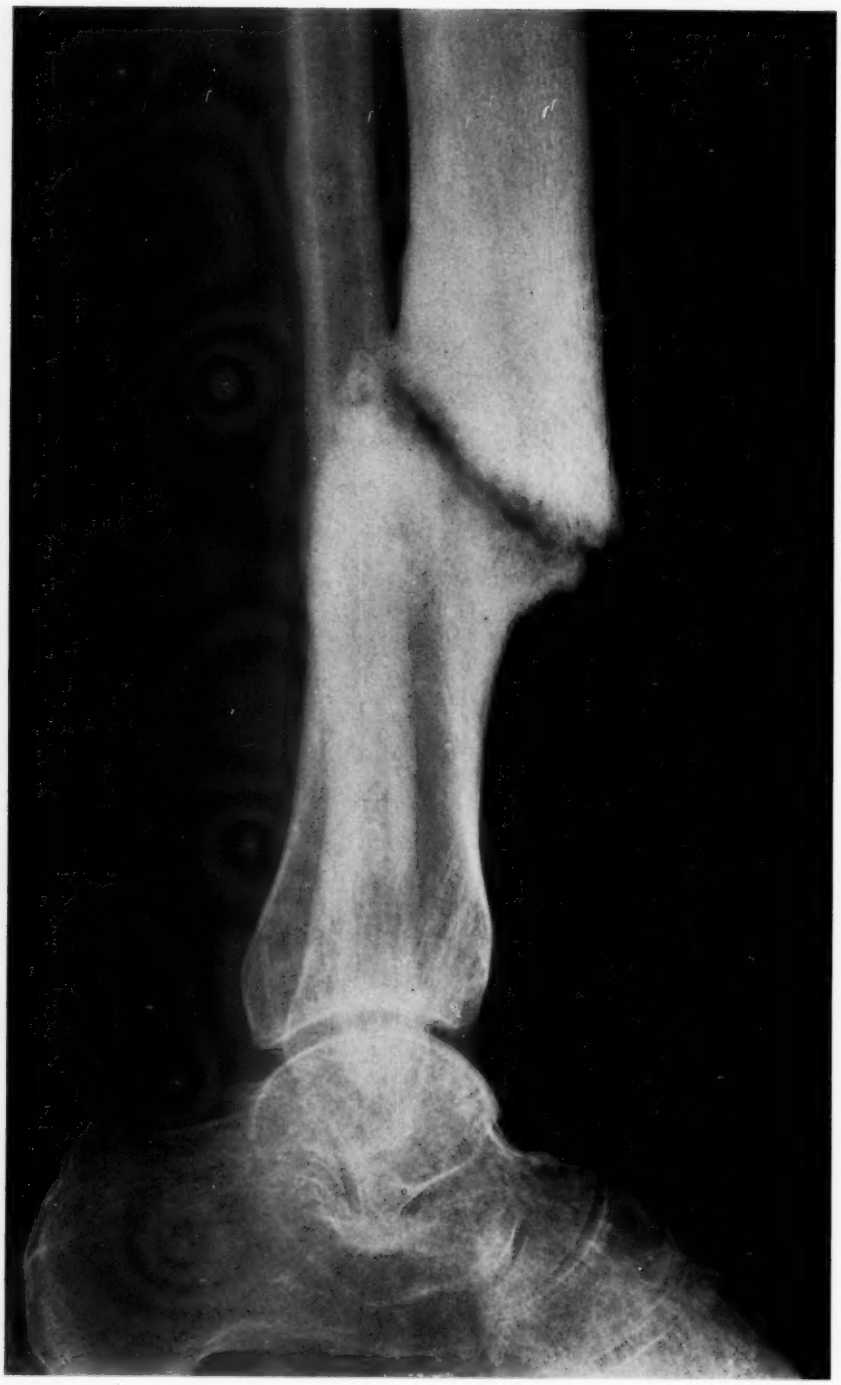


c

a, type of circular saw used. Note removable metal cap on distal end of shaft. In using the saw, the tip of the shaft which fits into this cap should be greased with sterile vaseline to prevent it becoming too hot to hold. All the metal can be dry sterilized. The flexible shaft is wrapped with a sterile bandage. *b* shows metal cap removed. *c* shows method of holding saw, which gives the operator easy control.

FIG. 3.



Ununited fracture of lower ⅓ of left tibia, 1½ years after injury.

FIG. 4.

Shows transplant used to bridge fracture in one of our early cases. The transplant was removed from the crest of the tibia and not from the internal flat surface.

FIG. 5.

Non-union after 1½ years.

FIG. 6.

Shows transplant used to bridge the fracture. Silver wire was used contrary to our late technic; also, the transplant was removed from the crest and not from the flat internal surface.

plant is then inverted so that sound bone will bridge the line of the fracture. The part which was the upper end fits into the angle distal to the fracture in the smaller fragment. The piece removed from the smaller fragment is then used to fill the remaining gap in the longer fragment. Both pieces are sewed in by stitching the periosteum of the transplant to the periosteum of the shaft. The skin is then closed with silk-worm and horse-hair and the dressing applied. A plaster-of-Paris cast is applied to include the knee and ankle. This is removed at the end of two weeks. Sutures are removed and a new cast put on which is left for from 4 to 6 weeks. Further treatment is guided by the individual case. Union is usually firm enough to permit walking in from 3 to 6 months.

Case A71534.—X-ray 16559. Male, aged thirty-one. Mining engineer. Date of examination in Mayo Clinic August 2, 1912. Twenty-six months previous to examination, the man had sustained a compound fracture in the lower third of the tibia and fibula. No infection followed. In spite of good treatment by cast, splint and brace, there was but little union and that was fibrous. In October of 1911, he contracted syphilis, which was treated promptly and effectively. At the time of examination in our clinic, although he had had no treatment for 2 months, his Wassermann was negative. He was walking with the aid of a brace but had been unable to resume work.

Operation.—On August 12, 1912, the fracture was exposed and a transplant was moved down from above to bridge the fracture. Healing by first intention followed and the patient was dismissed. Three months later he wrote that the union was firm and asked permission to bear weight on his leg. This he was advised to do gradually.

Case A78083.—X-ray 18621. Male, aged thirty. Farmer. Date of examination January 3, 1913. Patient presented himself for examination because of delayed union of a compound fracture of the left tibia of 1½ years' standing. Infection followed and he was quite ill for 2 months. At the time of examination in our clinic, there were no signs of infection. He had been treated by splints and casts. The union was entirely fibrous, there being free motion at the site of the fracture, and he was using two crutches (Fig. 3).

Operation.—On January 6, 1913, the fracture was exposed and a piece of bone four inches long transplanted from the middle third of the same tibia to bridge the fracture (Fig. 4). Healing occurred by first intention. On May 15, the patient resumed his full duties on the farm. Probably firm union had existed for 6 weeks prior to that time.

CASE A78224.—X-ray 18668. Male, aged twenty-eight. Miner. Examination January 7, 1913. Delayed union of fracture of the middle third of right tibia, 1½ years' duration. There was free motion at site of fracture. Two crutches were used. Amputation had been advised by home physicians.

Operation.—On January 9, 1913, bone was transplanted from the same tibia to bridge the fracture. Instead of using catgut as usual, aluminum bronze wire was used. A scar which was the result of the original accident sloughed after being lifted up at the operation. Under alcohol dressings this surface granulated and healed without infection. The patient did not resume his full duties until September 2, 1913. He wrote that the leg was strong before that time but he was afraid to use it. A medicolegal question in this case may have prolonged the convalescence.

CASE A80259.—X-ray 19480. Male, aged thirty-two. Laborer. Weight 200 pounds. Examined in the Mayo Clinic February 19, 1913. One year previous, he had sustained a simple fracture in the upper third of left tibia. There was delayed union, and at the end of 6 months the fracture was wired, but without resulting union. When he came for examination, he was still using two crutches.

Operation.—On February 22, 1913, a transplantation was done on the same tibia to bridge the fracture. Primary healing followed and the patient was dismissed with a leather-sheath brace and crutches. On May 11, 1913, he slipped, throwing all his weight on the fractured leg. There was an injury and he returned for treatment. X-ray disclosed a new fracture which had occurred at the point where the upper end of the transplant had been removed. The old fracture was intact. A plaster-of-Paris cast was applied. The patient resumed his work on November 20, 1913, and reports the leg to be solid and straight.

CASE A82916.—X-ray 20710. Male, aged thirty-four. Laborer. This patient was examined April 16, 1913. Nine months previous to the examination, he had sustained a simple fracture

in the middle third of the right tibia and fibula. Casts and splints were used. After four months, he was operated on for delayed union by his home physician. Silver wire was used. No union resulted and his physician referred him to the Mayo Clinic for treatment. He was on crutches.

Operation.—On April 19, 1913, the fracture was opened and a portion from the same tibia transplanted to bridge the fracture. Primary healing occurred. On October 27, 1913, the patient resumed his full duties and in a recent letter stated that he had walked 10 miles.

CASE A82640.—X-ray 20553. Male, aged eight. Date of examination April 9, 1913. Five and one-half years previously had sustained fracture of the middle third of the right tibia. Malposition and imperfect union resulted. Two years ago he sprained his right ankle and examination by the X-ray disclosed non-union of the tibia. It was wired but no union resulted. In August, 1911, a Lane plate was applied but infection followed, and in November, 1911, the plate was removed. Following the removal of the plate the leg seemed to become perfectly straight and quite solid but at about the eighth month, though the leg was straight, there was motion at the site of the fracture. The union became gradually weaker with more motion and the deformity steadily increased. High shoes had been worn to come up over the fracture for more than a year.

Operation.—On April 9, 1913, bone was transplanted, the transplant being obtained from the same tibia. There was a slough of the skin, the result of the poorly nourished old scar, but no infection occurred and the patient's recovery was uneventful. A recent letter states that he is running and playing without any support and the leg seems perfectly solid.

CASE A87500.—X-ray 22915. Male, aged thirty-two. Farmer. Examination July 9, 1913. On May 12, 1913, he sustained a compound fracture of the left tibia and of the middle third of the fibula. No infection followed. No union other than fibrous occurred. The fibula had united.

Operation.—On July 11, 1913, bone was transplanted from the same tibia to bridge the fracture. The healing and convalescence were uneventful. The patient resumed full duties by November 1, 1913, the leg being perfectly firm and solid.

CASE A89982.—X-ray 22221. Male, aged forty-eight.

Farmer. Examination June 16, 1913. Two months previous had sustained fracture of the lower third of the left tibia. There was slight anterior displacement of the lower fragment and non-union.

Operation.—On July 17, 1913, a transplantation was done from the same tibia to bridge the fracture which was comminuted. A letter from the patient dated December 11, 1913, states that he is walking with a cane. The convalescence was slow in this case, largely because of trauma at the time of the fracture. There was much swelling of the soft tissues, even two months after the fracture occurred.

Case A97369.—Male, aged twenty-two. Chauffeur. Examined December 17, 1913. On November 25, 1911, he fractured lower third of right tibia and was treated by splints, casts, etc., until May, 1912, when an operation was performed. Bone transplant and silver wire were used. No union resulted.

Operation.—On December 23, 1913, in the Mayo Clinic a piece of bone 4 inches long was removed from the middle third of the tibia and used as a transplant to bridge the fracture. The wound healed by first intention.

THE TREATMENT OF UNUNITED FRACTURES OF THE TIBIA BY BONE TRANSPLANTS.

A REPORT OF FIVE TRANSPLANTATIONS WITH FIRM BONY UNION.

BY ERNEST F. ROBINSON, M.D.,

OF KANSAS CITY, MO.

WITHIN the past twelve months five cases of ununited fracture of the tibia have been treated by me by the transplantation of bone with such uniform success and so little mechanical difficulty, that I desire to place them on record as a demonstration of what I believe to be the best and only certain method of securing union in this class of most obstinate and often almost hopeless injuries.

CASE I.—Patient, A. S., a Russian laborer forty years old, entered the General Hospital, November 27, 1912, with comminuted fracture of both bones of the left leg. The X-ray demonstrated displacement of a large fragment of bone of the tibial fracture with shortening of both bones. Fracture of both bones was in upper third. The limb was immobilized temporarily in blanket splint for three days and then in light plaster case. Limb was left immobilized for six weeks with occasional massage and passive movement. At the end of this time the deformity due to misplacement was easily palpable and limb was movable at point of fracture. The second X-ray at this time exhibited very little callus formation and no bony union. Open operation, January 14, 1913. Ends of tibial fracture were exposed and sawed so that they could be placed in apposition with no deformity. A piece of bone five and one-half inches long was removed from opposite tibia and introduced into medulla of ends of fractured tibia and approximated. Wound repaired and limb placed in plaster case immediately. For a week after the operation patient's temperature varied from 100° to 100.4°, pulse averaging 100. The sound limb was redressed at end of six days. Slight infection of surface wound was found. After this redressing, temperature and pulse have been normal. Silk-

worm-gut sutures. No evidence of infection on grafted side. At the end of four weeks patient was up and about on crutches. Recovery so far uneventful. February 10, 1913, walks about ward on his cast without pain. Bony union.

CASE II.—Patient, L. J., a German laborer, forty-seven years old, suffered a comminuted fracture of the left tibia and fibula, and a comminuted fracture of the left radius, as a result of a railway accident December 10, 1912. At the time of his admission to the Swedish Hospital it was noted that his body was covered with syphilitic rupia. This disappeared under mercury and large doses of potassium iodide in two weeks. An anæsthetic was given and his fractures reduced. A splint was applied to the forearm and a well-fitting plaster case to the leg. The arm united nicely. The leg, however, failed to show any evidence of bony union after eight weeks, and an operation was decided upon. This was performed January 28, 1913, at the City Hospital, under ether anæsthesia. A longitudinal incision seven inches long was made, just to the inner side of the crest of the tibia. The ends of the bone, while in good apposition, were not united but were covered with granulation tissue. A loose fragment, about one inch long, was detached from the posterior portion of the upper fragment. Owing to the great irregularity of the broken bone, the ends were cut off with a chain saw and the granulation tissue in the medullary cavity was reamed out for a distance of about two inches. The crest of the opposite tibia was now laid bare and a piece of bone about five inches long was removed. This was detached with the chisel after the crest had been cut to the required depth at either end with the saw. No attempt was made to remove the periosteum from the transplant. This was now immediately driven into the reamed out end of the lower fragment. Traction was made upon the leg and this large bone peg was inserted into the upper fragment and the bones brought into accurate apposition. A small nail was driven into the upper end in order to keep the transplant in place. The muscles and fascia were brought together with a few catgut sutures and the wound closed without drainage. The leg was put up in a plaster case. Primary union resulted. Six weeks later firm bony union had resulted.

CASE III.—H. E. C., General Hospital, carpenter, broke his tibia and fibula, about middle, by a fall from a scaffold. No union

FIG. 1.

Bone transplant for ununited fracture of tibia.
(Case I.)

FIG. 2.

Bone transplant for ununited fracture of tibia.
(Case II.)

FIG. 3.

Bone transplant for ununited fracture of tibia.
(Case III.)

FIG. 4.

Bone transplant for ununited fracture of tibia.
(Case IV.)

after nine weeks. Operation December 30, 1913. Incision four and one-half inches, slightly curved just to outer side of tibial crest. Several small fragments of bone removed from between the ends of the broken shaft. A transplant about four inches long by one-half by one-half inch was cut from the crest of the opposite tibia with a chisel and saw. This was inserted into the reamed out ends of the upper and lower fragments and the bones brought accurately together. A plaster case was applied. After ten days this was replaced by another, correcting the slight deformity shown in the X-ray picture. Firm bony union resulted.

CASE IV.—C. W., a mulatto thirty-five years old, laborer, suffered a comminuted fracture of the right tibia as a result of a fall in July, 1913. Dr. Carbaugh reduced the fracture and retained it in good position by splints and later a plaster case. Ten weeks after the accident, however, only fibrous union had taken place. September 21, 1913, he was taken to the hospital. Under ether anæsthesia an incision five inches long was made just to the outer side of the crest of the tibia. Fibrous tissue and muscle fibre was found between the ends of the broken bones. The ends of the fragments were cut off with a chain saw, both bones were reamed out for a distance of two and one-half inches with a Murphy reamer. A bone transplant about four and one-half inches long and one-half inch wide and thick was removed from the crest of the opposite tibia. This was easily and quickly accomplished by a Hey's saw and chisels. It was doubly clamped to avoid the danger of dropping it. The transplant was then driven into the reamed out end of the upper fragment and aided by extension pushed into the lower fragment. This held the bones most accurately in apposition. Primary union resulted with firm bony union at end of seven weeks.

CASE V.—A. H. S., thirty-three years old, bridge carpenter, suffered a fracture of tibia and fibula as a result of a fall in January, 1913. After seven weeks there was no evidence of bony union. A removable case was applied and he was advised to walk upon the injured leg. After two weeks of this treatment there was still no evidence of union. Operation April 28, 1913, a five and one-half inch incision was made over the tibial crest and the ends of the broken shaft cut off by Gigli wire saw and rongeur forceps. A transplant about five inches long by

one-half by two-fifths of an inch was removed from the crest of the opposite tibia. This was inserted into the reamed out end of upper fragment for about two and one-half inches. A groove was cut in the lower fragment to admit the transplant, which was pushed down into the reamed out cavity in the lower fragment. The wound was closed without drainage. Primary union resulted. Bony union was somewhat delayed, owing, probably, to the fact that the patient left the hospital and wore the same case for several weeks. Twelve weeks after operation, however, we had an opportunity of examining the leg. Patient was then walking about with a loose case still, which gave him no support. Upon its removal it was found that good bony union had taken place. Union in this case would have undoubtedly been more prompt had the patient not taken upon himself the responsibility of the after treatment.

My own experience would lead me to believe that non-union of the tibia and fibula is by no means uncommon. This seems particularly true when the fracture occurs at about the middle or upper third. I am inclined to think that a thrombus, developing in the nutrient artery of the tibia (which enters the bone at this point), is probably the explanation. In consequence of this impaired nutrition the process of bone repair is so delayed that connective tissue is interposed and forms a permanent block to the bridging across the gap by the Haversian system of osteoblasts. Murphy's contention seems most logical that the autogenous bone graft or transplant acts as an osteoconductive superstructure which carries the bone forming process across. If this is true a properly placed transplant, well in contact with either fragment, cannot fail, if it extends well beyond the infiltrated area, to bring about bony union in all cases of ununited fracture.

In my transplants I did not remove the periosteum. In two of the cases, however, in forcing the transplant into the reamed out ends of the tibial shaft the periosteum was completely striped off from the lower half of the graft. Nevertheless union occurred just as promptly as when it remained perfectly intact. This would bear out Macewen's statement

that the periosteum is not essential in the bone-forming process.

It will be noted in these cases that no effort was made to secure union of the fibula. Perfect anatomical union of this bone is not essential, as the weight is all borne by the larger bone. In cutting the transplant a special dental engine or circular electric saw is of course most convenient. It is not, however, essential to accurate or rapid work. At the ordinary well-equipped hardware store one can secure a small triangular cabinet-maker's or wood-carver's chisel, which very materially aids in cutting the long transplant without danger of splitting or splintering. It materially helps, also, in loosening the graft after it has been outlined with the grooved chisel, if the splitting force of the larger chisel is applied from beneath the crest of the tibia upward. The bone then breaks in the grooved lines. Transplants six to ten inches long can be cut in this way with safety.

No drainage was used in any of my cases. The application of a tourniquet materially aided me in working rapidly. In none of my cases was the gloved hand, or any gauze, or any instrument that had come in contact with the skin, allowed to touch the wound, thus greatly lessening the danger of sepsis.

The ultimate result in these cases has been firm, bony union with but little callus formation. In the two earliest cases this has been so absorbed that almost no deformity whatever can now be detected.

TRANSVESICAL PROSTATECTOMY IN TWO STAGES.

BY PAUL MONROE PILCHER, M.D.,

OF BROOKLYN, NEW YORK.

I. THE PATHOLOGY OF CHRONIC PROSTATIC OBSTRUCTION. II. CONDITION INFLUENCING THE CHOICE OF TREATMENT-METHODS. III. THE THREE PHASES OF INTERRELATION BETWEEN OBSTRUCTION AT THE VESICAL OUTLET AND RENAL FUNCTION. IV. THE INDICATIONS FOR AND THE TECHNIC OF SUPRAPUBIC CYSTOSTOMY. V. TECHNIC OF TRANSVESICAL PROSTATECTOMY.

INTRODUCTION.

SINCE we have adopted the transvesical operation for the relief of urinary obstruction due to changes in the prostate, we have been able more fully to study the so-called living pathology of the condition inasmuch as the vesical outlet can be studied with the prostate *in situ,* the nature of the obstructing mass determined and the resultant deformities of the bladder studied. The removal of prostates in one piece in many cases and the interurethral enucleation in others has provided us with new material for extending our observations concerning the gross pathology of the disease.

Studying this last series of cases we are led to disagree with some of the more recently advanced theories concerning the pathology of the disease. In presenting this subject, therefore, we first offer our observations on the points in question. We do not reiterate much of the work which has already been published by Dr. Lewis S. Pilcher and myself.[1]

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[1] Pilcher, Lewis S.: Choice of Operative Method for Removal of the Hypertrophied Prostate. ANNALS OF SURGERY, 1905, xli, 565.

Observations Upon the Removal of the Prostate for the Cure of Prostatic Dysuria. *New York State Journal of Medicine,* June, 1906.

Urinary Obstruction from Prostatic Hypertrophy. *Year Book of the Pilcher Hospital,* 1911, i, p. 60.

Pilcher, Paul M.: Pathology and Etiology of Obstructive Hypertrophy and Atrophy of the Prostate Gland. ANNALS OF SURGERY, 1905, xli, 481.

Choice of Operation for the Relief of Prostatic Dysuria and the Pre-

I. THE GROSS PATHOLOGY OF PROSTATIC HYPERTROPHY.

Most of the recent articles dealing with prostatic hypertrophy have presented evidence and theories concerning the gross pathology of the prostate. The work of Tandler and Zuckerkandl (1) tended to show that all of our previous ideas of the gross pathology of prostatic hypertrophy were wrong. Lowsley (2) presented his study of a series of sections of the human prostate in its early developmental period, which were distinctly in contrast to the series presented by the Austrian scientists. Wilson and McGrath (3) presented their studies of over 400 specimens and agreed to a certain extent with the theories of Tandler and Zuckerkandl. Henry Wade (4) gives the results of his exhaustive study of prostatism and deals with the surgical anatomy and pathology of the operative treatment.

Our own observations have not satisfied us that these theories are absolutely demonstrated to the satisfaction of surgical pathologists. Lowsley agrees with the more advanced pathologists and recognizes five lobes in the prostatic mass. The middle lobe is quite independent of the others and its tubules are distinctly separated from the others. They are situated within the gland structure and are in relation with the floor of the urethra. The posterior lobe is situated furthest from the bladder and is almost an independent structure. It is further of interest to note that the tubules of the middle lobe lie side by side with those of the lateral lobes, but at no point do they intermingle. The lateral lobes are made up of a series of tubules on each side of the urethra and the acini of these lobes form the main mass of the gland. It is distinctly indicated that the lateral lobes are in direct relation with the urethra. The posterior lobe seems to be almost an independent structure and is seldom involved in hypertrophy of the gland. It, how-

liminary Treatment Indicated. *Journal of the Michigan State Medical Society*, January, 1912.

The Suprapubic Two-step Operation for the Removal of the Hypertrophied Prostate. *American Journal of Surgery*, June, 1912.

The Operative Relief of Obstructive Hypertrophy of the Prostate. *Journal of the Michigan State Medical Society*, September, 1913.

ever, seems to be a starting point for malignant degeneration in many cases. The subvesical accessory glands of Albarran, which develop on the surface of the median lobe, are not of much clinical importance in the experience of the writer.

As a result of our personal observations hereinafter detailed we believe:

1. That Tandler and Zuckerkandl are mistaken in their conclusions that prostatic hypertrophy is always a hypertrophy of the anatomical middle lobe.

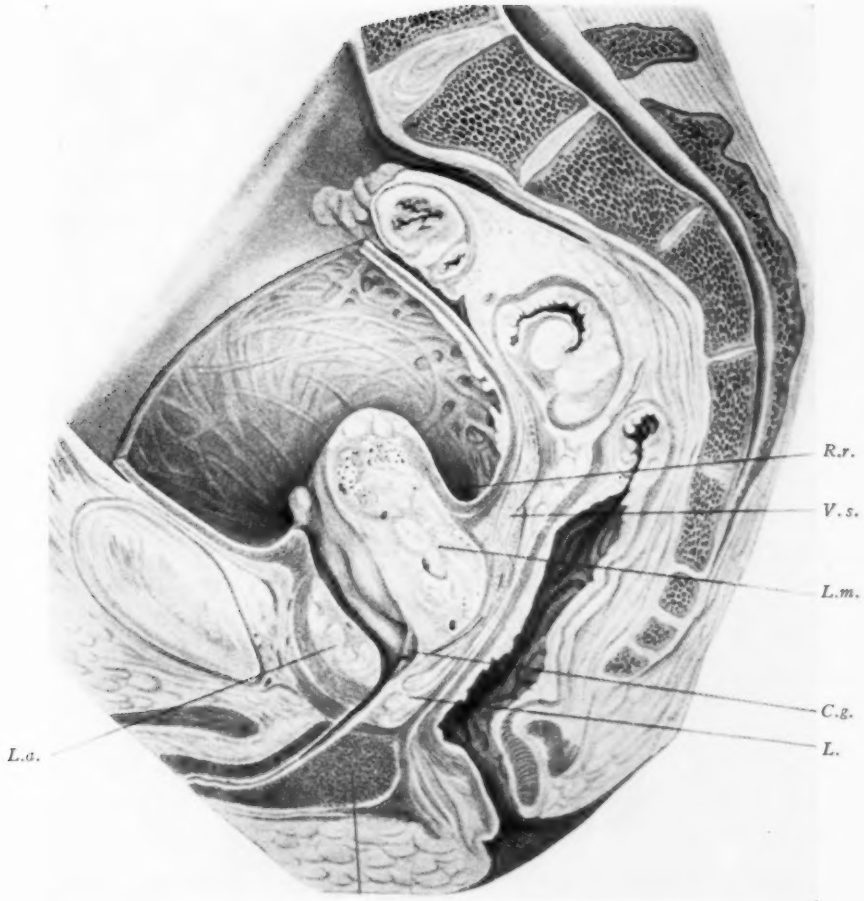
2. That Tandler and Zuckerkandl are incorrect in assuming that the so-called prostatectomy does not in a great majority of cases mean practically total removal of the prostate. We appreciate that in some cases of irregularly developed prostatic adenomata some prostatic tissue becomes atrophied and compressed and forms a shell around the adenomatous mass and is not entirely removed at operation.

3. We question that the surgical capsule is formed only by compressed peripheral parts of the prostate.

4. We agree that the anatomical relations of the hypertrophied prostate to the sphincter vesicæ, the bladder itself and the ductus deferentes recommend the transvesical route as the one to be chosen in removing an enlarged prostate.

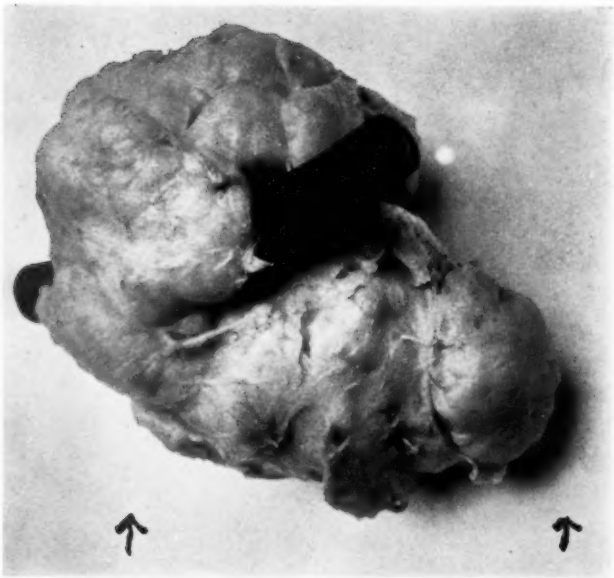
The first three of the conclusions advanced by the Austrians are so at variance with the accepted ideas of the pathology of the prostate in cases of obstructive hypertrophy, that the writer took occasion to visit Vienna and study the specimens which had been prepared by Professor Tandler and from which these conclusions were drawn. The writer spent some time in going over the question with Professor Tandler so that these observations are not based upon hearsay. Studying Tandler's specimens we accept his theory that the posterior lobe seldom hypertrophies. In other words, the enlargement takes place toward the bladder. However, in my mind the exhibits do not prove that the enlargement always involves the median lobe alone. If enlargement of the median lobe takes place, it must proceed along the avenue of least resistance, which is through the vesical outlet, gradually dilating it and forcing the sphincter

FIG. 1.



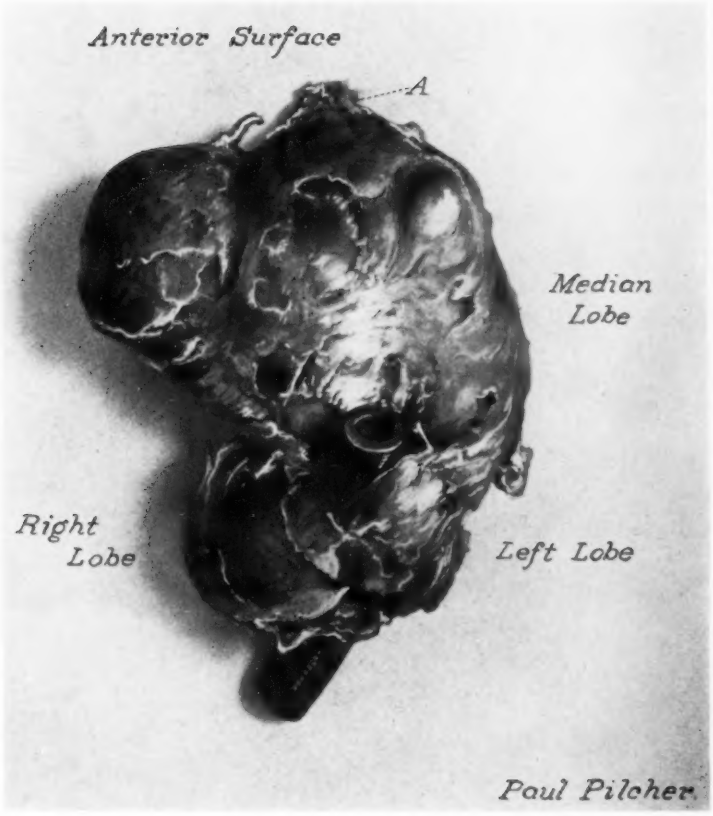
Sagittal section through the pelvis, showing the prostate hypertrophied. *B.u.*, bulbus urethralis; *C.g.*, caput gallinaginis; *L.a.*, lobus anterior; *L.m.*, lobus medius; *R.r.*, recessus retroureterieus; *V.s.*, vesicula seminalis. A short probe projects from the ejaculatory duct. (Tandler and Zuckerkandl, verlag von Dr. Werner Klinkhardt, Leipzig. Wilson and McGrath.)

FIG. 2.



Prostatic mass removed by transvesical operation, rubber tube showing direction of urethra. Beneath the rubber tube is a greatly hypertrophied middle lobe. The lateral lobes are seen forming the sides and roof of the urethra, but are not in any way obstructive.

FIG. 3.



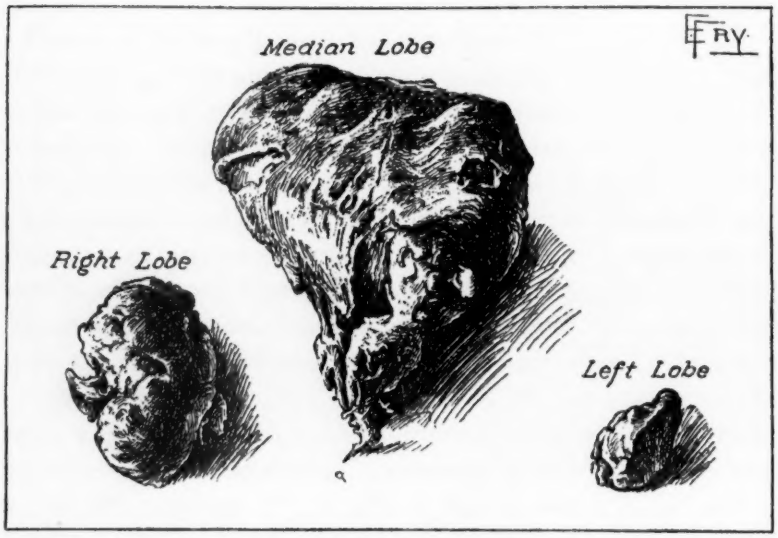
Enormous median lobe enlargement of the prostate with adenomatous changes in the lateral lobes. These lobes are smaller than normal and show no atrophy due to pressure. The specimen presents a view of the anterior face. The part above the rubber tube was entirely intravesical. The anterior face is covered by mucous membrane.

ring wide open. That this frequently occurs is well shown by many specimens. However, it is hard to accept the theory that in some cases, or in many cases, the enlargement of the median lobe takes place in the direction of the lateral lobes, displacing them and causing atrophy of these lobes, compressing them out into a shell-like capsule; to produce a lateral extension of an adenoma of the median lobe, the expansion must take place, not along the avenue of least resistance, but against a firm, well-developed structure. Judging from the anatomical relations as found on the operating table, Tandler's conclusions as to the part of the prostate involved in the obstruction are incorrect.

Fig. 1 is an illustration taken from the work of Tandler and Zuckerkandl, showing a sagittal section through the pelvis in a case of prostatic hypertrophy. We agree that this represents a typical case of median lobe enlargement. A number of other illustrations which are shown in the work of Tandler and Zuckerkandl are unquestionably examples of median lobe enlargement, for in each the adenomatous mass is more or less symmetrical in the median line and is forced through the sphincter dilating it. The same phenomenon has been plainly shown in many of our own specimens, for example, Figs. 2, 3, and 4. At the same time, the enlargement of the lateral lobes without the median lobe enlargement may take place, and in such cases the sphincter is greatly dilated and surrounds the hypertrophied mass. Such a case is seen in Fig. 5. In this case the lateral lobes have become enormously hypertrophied and have carried the median lobe, which is also enlarged, through the sphincter well into the bladder. It cannot be conceived that, after the enucleation which was accomplished in this case, any prostatic tissue was left behind unless it was the posterior lobe which is so nearly independent. Fig. 6, however, shows a different condition. This was a case of complete urinary obstruction, which had lasted for three years. *B'*, *B'* are the adenomatous lateral lobes. *B* is a greatly hypertrophied median lobe. *A* is a crescent-shaped calculus, and the remaining pieces of tissue are compressed and atrophied bits of prostatic tissue which still

remained imbedded in the capsule of the prostate after the adenoma had been enucleated. Fig. 7 is an example of symmetrical enlargement of the median and both lateral lobes. Fig. 8 is an example of bilateral hypertrophy without any median lobe enlargement. The specimen is very distinct and convincing on this point. Fig. 9 is another example of irregular hypertrophy of the lateral lobe with very little median lobe enlargement. Fig. 10 shows a specimen removed in one piece in which the median lobe is enlarged and has pushed forward into the bladder and distorts the urethra, lifting it up and mak-

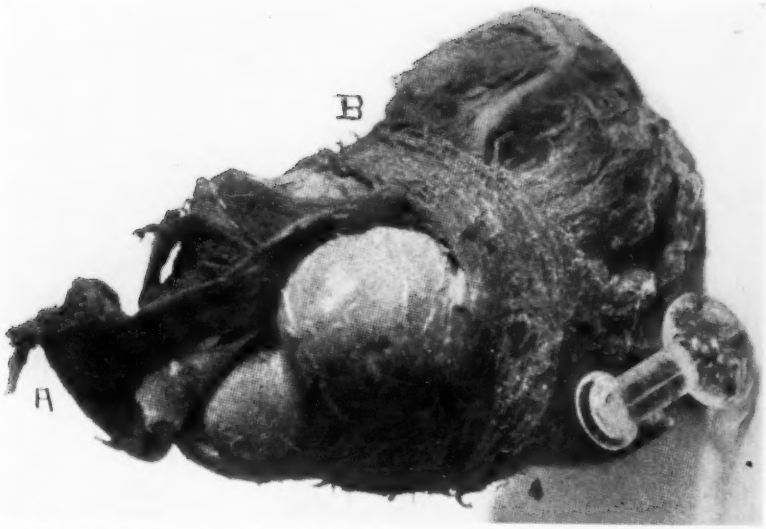
FIG. 4.



Drawing showing the three lobes of the prostate separated. Same specimen as Fig. 3.

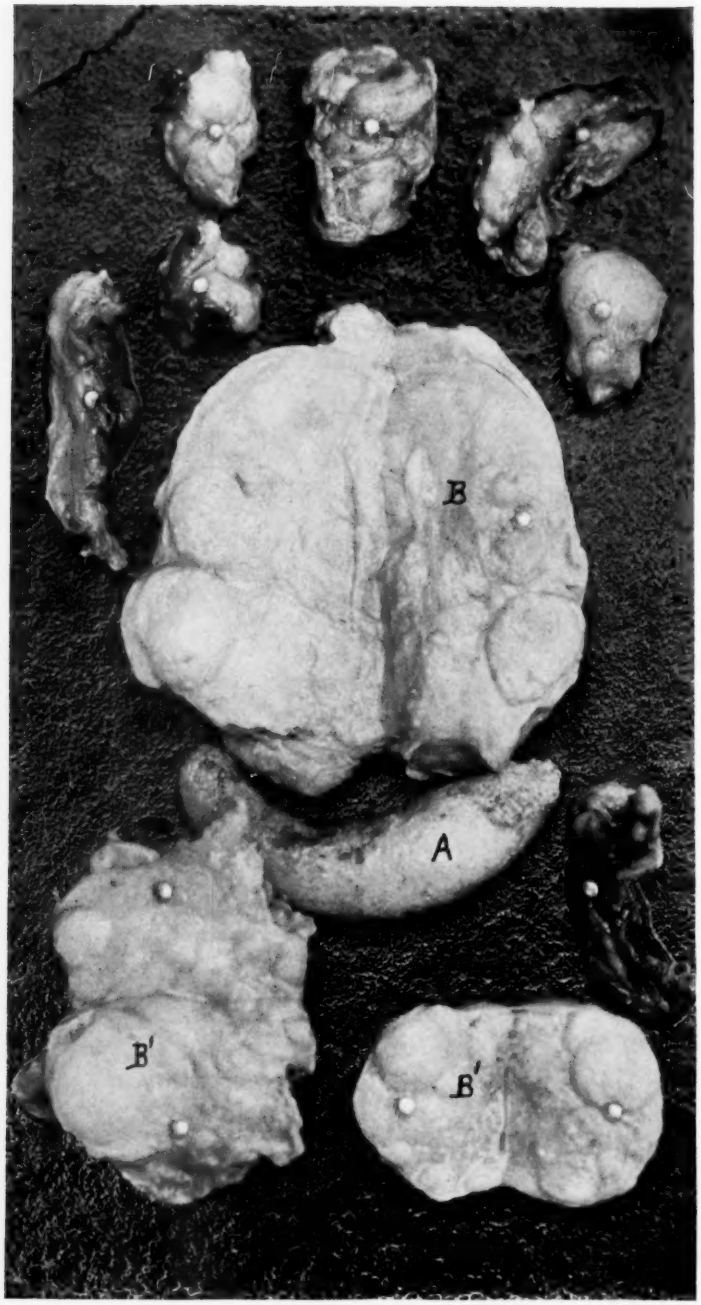
ing it almost impossible to empty the bladder. The position of the sphincter is indicated by the arrows. Fig. 11 shows still another type of development. The lateral lobes in this case had been previously removed by perineal operation. The symptoms persisted and three years later this median lobe enlargement, with a very freely movable ball valve attachment, was taken out by a transvesical operation. No remnants of the lateral lobes could be found. It is interesting to note the position of the internal sphincter as indicated by the arrows.

FIG. 5.



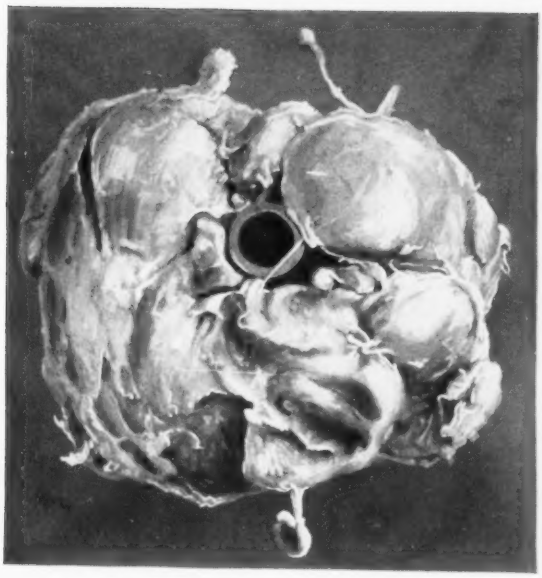
Photograph of hypertrophied prostate removed by suprapubic route. Showing bilateral and median enlargement. At vesical pole, *A*, the capsule and mucous membrane of the bladder are shown stripped back from the glandular portion of the gland. At *B* is seen the circular capsule which passes entirely around the gland.

FIG. 6.



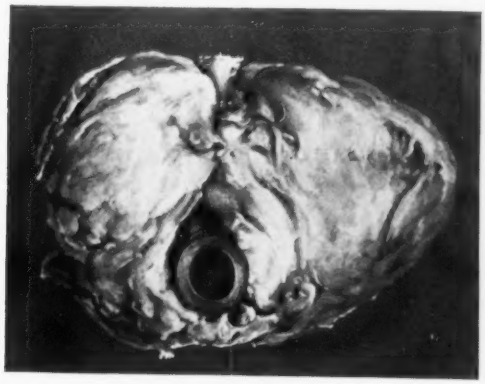
Photograph of prostatic masses removed by transvesical route. *A*, is a crescent-shaped calculus; *B*, a large median lobe; *B' B'*, the two lateral lobes. The other pieces of tissue shown in the specimen are atrophied prostatic tissue adherent to the capsule.

FIG. 7.



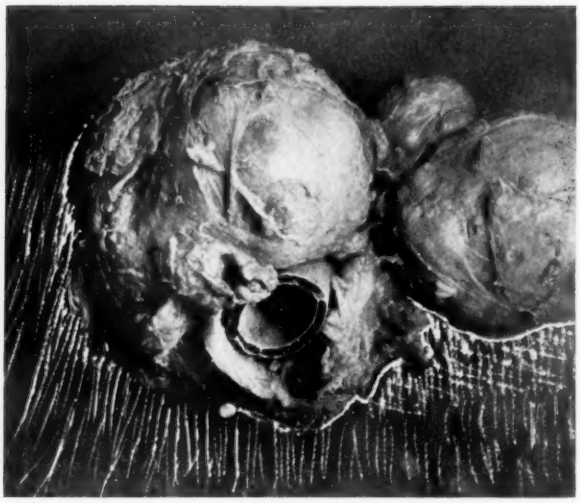
Specimen removed by transvesical operation showing symmetrical enlargement of both median and lateral lobes.

FIG. 8.



Specimen removed by transvesical operation showing hypertrophy of lateral lobes without involvement of median lobe.

FIG. 9.

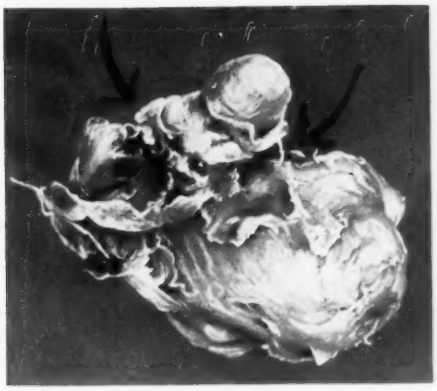


Specimen removed by transvesical operation showing irregular hypertrophy of the lateral lobes with very little median lobe enlargement.

FIG. 10.

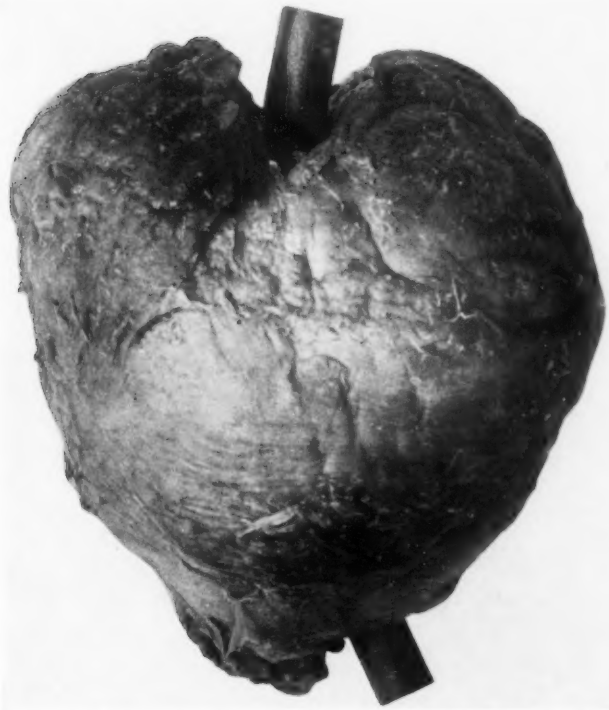
Specimen removed by transvesical operation showing marked median lobe enlargement with practically no lateral lobe enlargement.

FIG. 11.



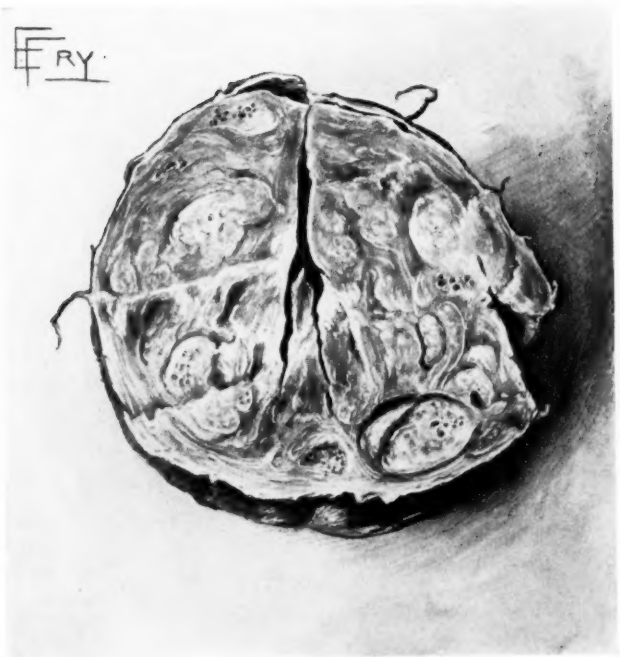
Median lobe enlargement with ball valve attachment.

FIG. 12.



Enlargement of the prostate in which the two lateral lobes are involved. The vesical surface of the prostate appears at the top of the picture. This specimen was removed within its capsule and is a perfect example of coincident hypertrophy of both lateral lobes without any marked median lobe enlargement. The section through this mass is seen in the following figure which shows the narrow cleft occupied by the urethra. The two lateral masses and the small adenomatous median lobe are seen.

FIG. 13.

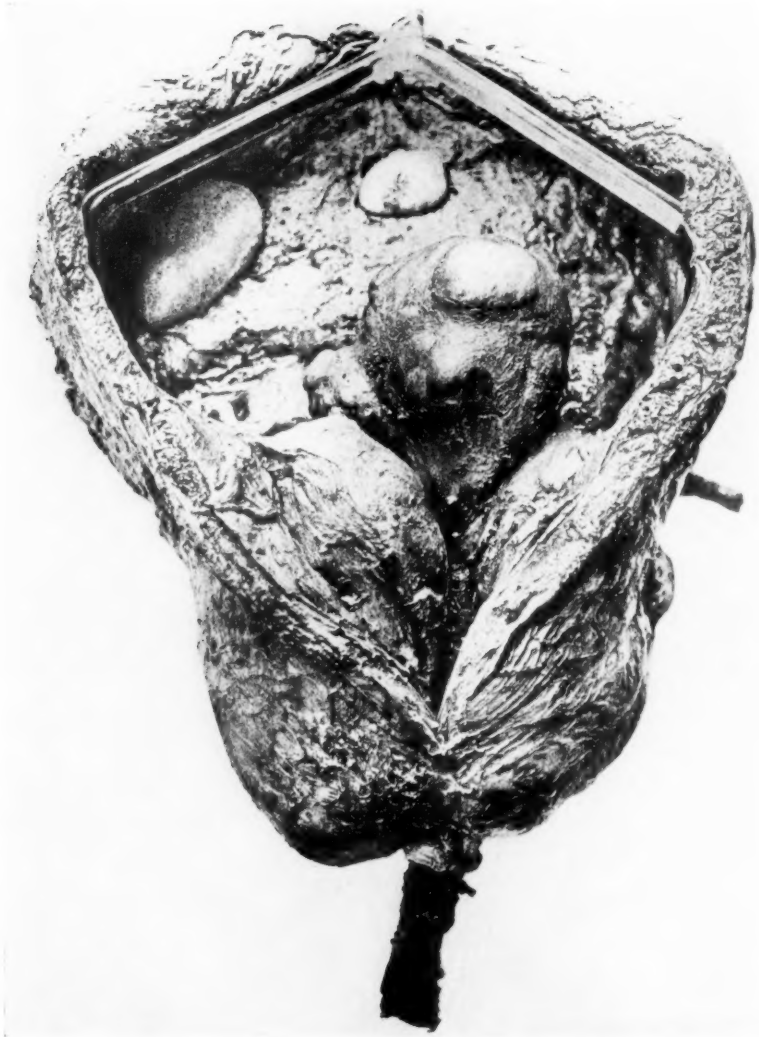


Cross section of specimen shown in Fig. 12 showing relation of median lobe and two latera lobes to the urethra.

FIG. 14.

Bilateral and median lobe hypertrophy of prostate. Position of colliculus. This photograph shows the exact relation of the urethra, hypertrophied prostate and bladder as an example of moderate bilateral hypertrophy of the prostate, with median lobe enlarged and projecting into the bladder, the median lobe forming the chief obstruction. Following the urethra upward from the bladder, it will be seen that the urethra inclines sharply downward due to the bulging of the median lobe, which forms the floor of the urethra as far forward as the colliculus. If the finger were introduced into the urethra through the bladder, it can be easily seen from this picture how the entire prostate could be removed without injury to the colliculus. (Reproduced from Francis S. Watson's work on The Operative Treatment of the Hypertrophied Prostate.)

FIG. 15.

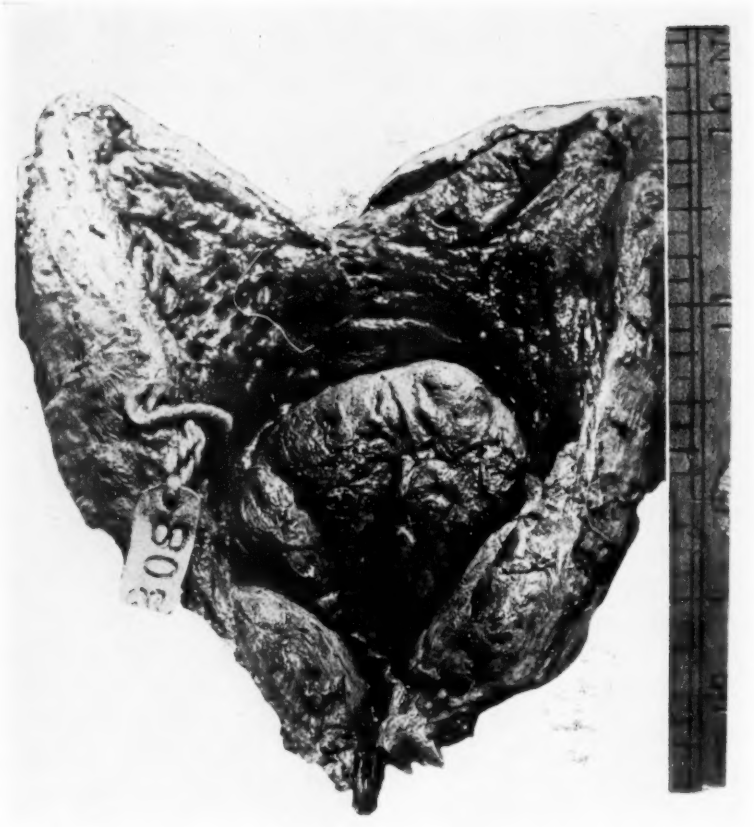


Photograph of bladder and prostate which speaks for itself. It is impossible to conceive how anyone would deny that this photograph represents a case of hypertrophy of both lateral lobes of the prostate and the median lobe. The photograph showing the distinct relation between the bladder wall and the specimen bears witness to the incorrectness of the conclusions of Tandler and Zuckerkandl when they say that such hypertrophy does not exist. (Reproduced from Francis S. Watson's work on The Operative Treatment of the Hypertrophied Prostate.)

FIG. 16.

Photograph of another specimen of obstructive hypertrophy of the prostate demonstrating another phase of hypertrophy of the lateral lobes. Position of the colliculus. In this case the two lateral lobes have developed unequally, that on the right side of the specimen being much the larger and distorting the urethra very greatly. Both lateral lobes are hypertrophied and the median lobe is represented by a thickened area which becomes a bar because of its being raised up and forced bladderward by the enlarged lateral lobes. If these hypertrophied masses originated from the median lobe, the floor of the urethra would be raised up, whereas the specimen shows the floor of the urethra only distorted in a lateral direction, while the floor is actually depressed. The position of the colliculus in this case is also well seen. (Reproduced from Francis S. Watson's work on The Operative Treatment of the Hypertrophied Prostate.)

FIG. 17.



Photograph of a perfect example of a median lobe enlargement without hypertrophy of the lateral lobes. (Reproduced from Francis S. Watson's work on The Operative Treatment of the Hypertrophied Prostate.)

In this case we had the obstruction of the enlarged mass and in addition a ball valve action.

Fig. 12 is the photograph of a specimen, actual size, removed in one piece. It is a perfect example of hypertrophy of both lateral lobes of the prostate. Fig. 13 shows a section through the centre of this mass and shows quite distinctly the three lobes, the two lateral lobes and the median lobe, and their position in relation to the urethra. The median lobe extends up like a wedge between the two lateral lobes and is only moderately enlarged. In this connection reference may be made to the series of photographs of specimens which were published in 1888 by Francis S. Watson, of Boston, in his treatise on the Operative Treatment of Hypertrophy of the Prostate. Plate 4 (reproduced here as Fig. 14) shows a very important feature; the lateral lobes are moderately enlarged, the median lobe is distinctly enlarged and is projecting into the bladder, forming the cause of the obstruction. Distal to the median lobe enlargement is seen a raised-up portion, which is the colliculus or verumontanum, at which point the vasa deferentia empty into the urethra. If the finger is introduced into the urethra by the transvesical route in enucleating the prostate, one can easily see from the specimen how the colliculus may be preserved. Fig. 15 is an undeniable example of hypertrophy of both the lateral and median lobes of the prostate. This specimen, which is a dissection not only of the prostate but of the bladder as well, shows exactly the relation which no drawing could so well express. Fig. 16 shows another phase which is a bilateral hypertrophy of the prostate with a slight median lobe development causing a distinct prostatic bar. The tortuous course of the urethra, the presence of the colliculus and its relative position are clearly shown. No one could argue that in these specimens such a hypertrophy originates from the median lobe alone. The floor of the urethra is very clearly shown and is seen to be free from all hypertrophied tissue. This portion of the urethra must invariably be involved, at least that portion between the colliculus and the sphincter, in all median lobe enlargements. Fig. 17 is a perfect example of median lobe enlargement alone.

In this case the lateral lobes are distinct, but not hypertrophied. The specimen shown in Fig. 18 shows well the part taken by the lateral lobes in some cases of obstructive prostatic overgrowth. The specimen was removed by the transvesical route, and the entire deformed portion of the prostate was removed in one piece. Fig. 18 shows the under surface of this prostatic mass. A rubber tube passing through the specimen indicates the position of the urethra. At the top of the specimen is seen a small collar which is the mucous membrane stripped up from the internal sphincter. This sphincter could be appreciated by a finger in the bladder. Fig. 19 is another photograph of this same specimen viewed from the anterior surface, showing, roughly, the course of the urethra, as exaggerated by the furrows produced by the presence of the rubber tube in the hardened specimen. The two lateral lobes which appear like the wings of a butterfly are joined together across the median line by a practically normal median lobe which is in no way hypertrophied. The collar of mucous membrane also appears at the top of this specimen and shows the lack of any bulging in the bladder. As far as could be appreciated by the finger, the entire prostate was removed in this case with the possible exception of the posterior lobe of the gland which was distal to the ducts, but the remains of which could not be appreciated by the finger. Examination of the cavity from which this prostate was removed, made immediately after the operation, demonstrated no tissue remaining which in any way resembled prostatic tissue. Fig. 20 is a photograph of a specimen removed the same day as the previous specimen and shows the prostatic mass as removed in one piece. The small drainage tube occupies the position of the urethra and shows it distorted and the presence of the greatly enlarged median lobe which extends into the bladder and lifts the urethra up. The bladder in this case is to the right of the specimen. As one views the specimen grossly, it would look as if the entire adenoma were one piece. When, however, the anterior commissure is divided, the specimen falls apart and forms three distinct portions; the two lateral masses, which are the lateral lobes, are greatly hyper-

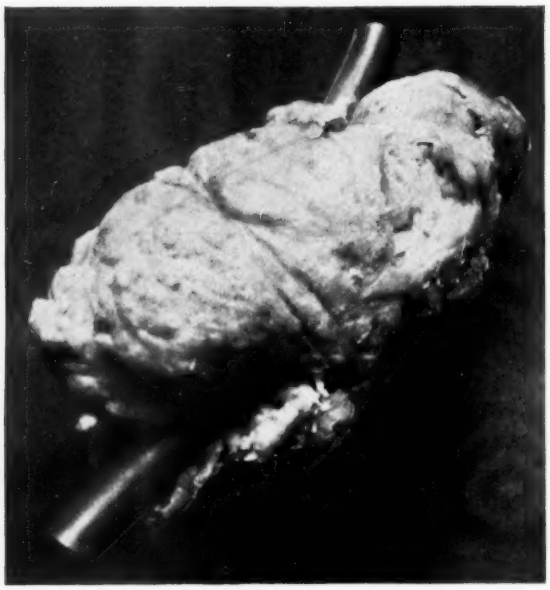
FIG. 18.

Specimen removed by transvesical operation, showing under surface in a case of enlargement of both lateral lobes.

FIG. 19.

Same specimen as Fig. 18. The anterior commissure divided, showing two lateral hypertrophied lobes and the normal sized median lobe joining the two enlarged lobes.

FIG. 20.

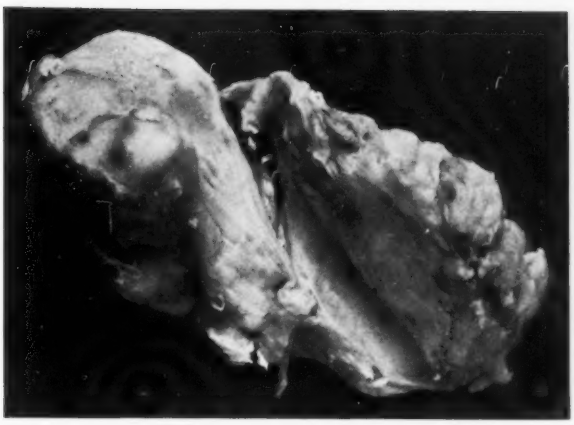


Specimen removed by transvesical operation showing the entire prostate removed in one piece.

FIG. 21.

Same specimen as Fig. 20. The anterior commissure divided allowing the hypertrophied right lobe to drop down, showing the relation of the enlarged middle lobe and the left lateral lobe to the urethra. The middle lobe is seen to form the floor of the urethra for a distance of about one and one-half inches, but does not extend as far up on the urethra as the lateral lobe.

FIG. 22.



Same specimen. Shows this same condition more clearly.

FIG. 23.

A close view, through cystoscope, of a dilated ureter opening with lax walls.

trophied and compress the urethra, the course of which is indicated by the furrow (Fig. 21). To the left in the upper quadrant of the picture is seen the median lobe which extends well down into the urethra, well past the first portion of the lateral lobes, in fact, forming a wedge-shaped lobe between the portions of the lateral lobes which extend into the bladder. However, the specimen clearly shows the relations of the two lateral lobes to the urethra. Fig. 22 shows another view of this same gland which indicates more clearly the exact position of the urethra and its relations to the lateral lobes and to the median lobe. In this specimen one lateral lobe has been removed and the furrow, as indicated in the specimen, shows the relation of the urethra to both the lateral and median lobes. The lateral lobe forms the side wall for over two inches, while the median lobe, passing beneath the urethra, extends along it for an inch and a quarter.

Our own deductions are based primarily on an analytical study of our own cases, taking into account, first, the conformation of the prostatic mass as presented to the cystoscopist and judged by the eye, and the mass as found *in situ* at the time of operation and appreciated by the finger; second, a careful determination of the adenomatous mass in relation to the opening of the urethra and the sphincter vesicæ; and third, a thorough gross and sectional examination of all our specimens after removal by the transvesical route.

Professor Tandler has not demonstrated conclusively that the lateral lobes of the prostate are compressed and atrophied by enlargement of the anatomical median lobe. If he could show us the various stages of the development of this phenomenon by microscopical section, we would be convinced of his argument, but he has not presented any microscopical sections showing the transition from the adenoma involving the median lobe and atrophy of the lateral lobes. Furthermore, before we could accept his theory of the enlargement being confined only to the median lobe, it would be necessary to show that the ducts leading from this lobe were entirely distinct from the ducts leading from the lateral lobes.

II. THE CHOICE OF TREATMENT.

Assuming the diagnosis to be correct, that is, that obstructive prostatic disease exists, how shall we determine the course of treatment? And when the indication for prostatectomy is present, what is the safest procedure?

1. PALLIATIVE MEASURES.—The establishment of a catheter life, destroying an obstructing mass by using the cautery or punch, or the high frequency spark, are all but temporary expedients. Any and all of these methods may be used to insure the patient's temporary relief, but invariably the patient continues to become more enfeebled, is constantly the slave of his bladder, his mind is never at rest and finally, as a rule, he must face either an operation or death. Certainly this fact has been most forcibly demonstrated in the recent survey of our non-operated cases. These cases naturally fall into three classes, those in which the urinary obstruction is due to benign hypertrophy of the prostate, in other words, a chronic interstitial prostatitis; second, those cases in which the obstruction is due to carcinoma of the prostate; and third, tubercular hypertrophy of the prostate.

In the first class, in those cases in whom the obstruction has developed to that stage where the use of a catheter, either at intervals or every day, has become necessary to insure their comfort, infection sooner or later takes place, followed by sepsis, uræmia, etc., and the average length of life is less than three years. This is a little longer than the average time found in Squier's recently tabulated cases. All of this time, however, the patient lives in filth and misery and is a burden to himself and a trial to his friends.

In the second class of cases, the unoperated malignant growths of the prostate, no average can be stated which is of much value. The progress of cancer in the prostate is slow as a rule, but where there is much obstruction due to the growth, the combination of uræmia and the effects of the cancer often terminate the life of the patient within a year.

In the last 28 cases of benign hypertrophy of the prostate, which comprises all cases operated upon within the last two

years, during which the new method hereinafter to be described has been followed, we have secured 100 per cent. recovery. In the malignant growths covering the same period, consisting of six cases, there has been one death. In this case besides removing the prostate, the base of the bladder and the seminal vesicles were also resected.

RESULTS.—*In the non-malignant cases* above mentioned the average length of life is limited by old age and the various ills incident to its progress. All of the cases have had full control of their urine and they have returned to their normal health again. *Of the malignant cases,* one patient is living two years and two months since his operation and is now showing marked cachexia, but is still able to void his urine without the use of the catheter. A second patient is living, one year and two months since his operation, with marked symptoms of carcinoma involving the rectum, but is still able to empty his bladder. A third case died 12 hours after the operation. A fourth is still living, four months after operation, with no symptoms as yet referable to the bladder; complete control and voids normally. The fifth case was operated upon two months ago; still no symptoms of return and voids normally. The sixth case is still in hospital making a good recovery. *One case of tuberculosis* of the prostate was operated upon in which the prostate was removed by this method. The patient recovered and is to-day perfectly well, one year and four months since the operation.

2. OPERATIVE CONSIDERATIONS.—*The chief indication.* If practitioners and surgeons will hold in mind the fact that *the chief indication is primarily to relieve the retention of urine rather than the removal of the prostate,* the entire subject of obstructive prostatic disease will assume a different aspect. If we could dissuade surgeons, as a rule, from the course of immediately taking out a prostate which is known to be obstructive, we would do much to help the cause of the prostatics.

There are two methods of accomplishing the relief of the retention of urine, and one of these two methods should comprise the first step in every operative encroachment upon the

bladder for this disease. First is the use of an indwelling catheter which systematically drains the bladder for a definite period of time until the kidney has reacted from the changed condition. This method may also be used to clear up the cystitis. The second method is a suprapubic cystostomy and the introduction of a permanent catheter occupying the cystostomy wound for the same purpose as an indwelling catheter.

Before discussing the relative values of these two methods, one of which should always be employed before prostatectomy is considered, I wish to present a few facts which demonstrate that retention of urine in the bladder in prostatic disease has a very distinct and fundamental effect upon the general economy.

The Kidney as Affected by Prostatic Hypertrophy.—First, clinical evidence: The clinician will observe, in cases of prostatic disease in which there is considerable retention of urine, that the most marked symptoms will be evidences of intestinal stasis, loss of appetite, loss of sleep, changes in temperament, mental degeneration, lack of personal pride, loss of weight and a general deterioration of the entire organism. Aside from this, further examination will show various phases of uræmic poisoning; in many cases a very marked increase in the secretion of urine with low specific gravity. Frequently the amount of urine will reach 150 ounces in 24 hours and its specific gravity be as low as 1002. In a recent case the 24-hour record was over 300 ounces. This, of course, is an index of functional derangement of the kidney. The rapid disappearance of all these clinical evidences of disturbed renal function, which follows draining of the bladder, shows the direct relation of cause and effect.

We have both acute and chronic, partial and complete forms of obstruction.

In the cases of *chronic partial obstruction* it has been noted in general that the amount of urine secreted is increased, providing the bladder is strong enough to regularly overcome the partial obstruction, and partially empty the bladder so that at no time the back pressure from the bladder is continually great. Where the musculature of the bladder is not so strong,

and there is a chronic retention of a considerable amount of urine with very little overflow, the amount of urine secreted will often average as high as 120 to 150 ounces in twenty-four hours with a low specific gravity.

Where we have a contracted bladder with greatly thickened walls, in which there is only a small amount of retention, and the amount of retained urine almost entirely fills the contracted bladder, the urine is passed very frequently and in small amounts. Such a bladder may contain only two or three ounces and is almost continuously full. Under such conditions the kidney seems to diminish its secretions. The total amount secreted in twenty-four hours may be very little, finally resulting in complete anuria.

The other cases are those of acute retention of urine, in which the kidneys act freely until the bladder is filled to its capacity, at which time the kidneys stop acting entirely. It must be remembered that the bladder will never rupture from overdistention due to accumulation of urine.

Aside from the clinical evidence of renal infection and renal insufficiency already presented, the most striking evidence of renal injury due to prostatic obstruction is presented in those cases dying from the disease. Autopsy shows a variety of conditions existing in the kidney, the lesion most common to all being a hydro-ureter beginning immediately above the bladder, resulting in various degrees of hydronephrosis and destruction of the kidney parenchyma. This in turn is influenced by the degree and duration of the obstruction and in more advanced cases is accompanied by infection, the formation of renal calculi, and, in some cases, by actual infection and destruction of the kidney parenchyma.[2]

To the mind of the writer those lesions are brought about by two mechanical conditions: 1. The hypertrophy of the muscular walls of the bladder through which the lower end of the ureter passes and, 2, the constant presence of residual urine which helps to keep the muscles compressed and forming a

[2] Wade: Prostatism, Fig. 40. March ANNALS OF SURGERY, p. 334.

chronic obstruction extending over that portion of the ureter which passes through the bladder wall. It is the exceptional case in which the infection is an ascending one, but usually, in my opinion, it is due to hematogenous and lymphatic infection of a tissue whose resistance has been greatly lowered by mechanical obstruction.

Second, objective symptoms: The cystoscope shows that many changes have taken place in the bladder. First, we note that the muscular walls are markedly changed. They are hypertrophied and trabeculated, and false and true diverticula are formed, and occasionally calculi of various sizes and shapes are seen. Occasionally, also, the infection of the renal pelvis which follows retention of urine predisposes to the formation of renal stones which may be shown on the X-ray plate.

The cystoscope, as a rule, shows the *ureter opening* raised up on a ridge with the interureteric fold quite distinct. The ureter opening in the majority of cases is normal with the exception that it is changed by the general muscular hypertrophy which surrounds it. Occasionally the ureter opening is dilated, as is seen in the accompanying illustration (Fig. 23).

Third, the operative proof: From a careful study of a series of cases in which a preliminary cystostomy was done, certain phenomena were repeatedly observed which seemed to justify us in dividing the sequelæ to advanced prostatism into three phases. It has further emphasized in our minds the peculiar balance existing between the heart, kidney, secretion of urine, and the nervous control of these in the patient who has gradually become used to over-distention of the bladder. The pathology of this condition has already been referred to.

We have learned not to rely upon any one clinical sign or symptom in judging the fitness of the patient for operation. We have learned that the balance between the various elements of the system are so adjusted that a disturbance of one element will bring to light weakness in some of the other elements which has not been suspected, for example, *the phthalein test.* This *may be very deceptive.* The patient may show 60 to 70 per cent. of excretion of phthalein in two hours before anything

has been done to relieve the retention of urine. But disturb the retained urine in the bladder and all of the other elements of the system are thrown into confusion. The back pressure is relieved; decompression of the kidney follows; swelling and congestion of the kidney takes place; and the functional capacity of the kidney immediately drops to a very low point. The outward signs of the derangement of this unbalanced kidney are very evident. This is the second phase. It is our belief that many of the cases which have died following operation are the result of a lack of appreciation of this second phase of a renal disturbance in prostatics. Many deaths have been reported on the third to the fifth day following a one-step prostatectomy, when the patient was seemingly doing well; but when we add the phenomena of the second phase to the shock of the major operation with its loss of blood and the depressing effect of the general anæsthetic, it can be easily appreciated why these deaths take place, and many will agree that the overtaxed heart and the system overloaded with toxins which the kidneys should separate from the blood are the cause of death. Our extended observations have shown us that nearly every prostatic will present these three phases, and this fact has influenced us very greatly in favor of the two-stage operation in every case of benign hypertrophy.

III. THE THREE PHASES.

The results of our observations are graphically shown on the accompanying chart, Fig. 24, which shows the average condition which prevails in many advanced cases of obstructive hypertrophy of the prostate.

The First Phase.—For the first day, the day on which the suprapubic cystostomy is done, the blood-pressure frequently registers from 200 to 220 mm. of mercury; the urinary output for 24 hours will average from 70 to 120 ounces; the phenol-sulphone-phthalein test will frequently average above 60 per cent. in two hours and the urine will show only a trace of albumin. If these conditions are considered by themselves, they will give us a false impression of the actual condition of the

FIG. 24.

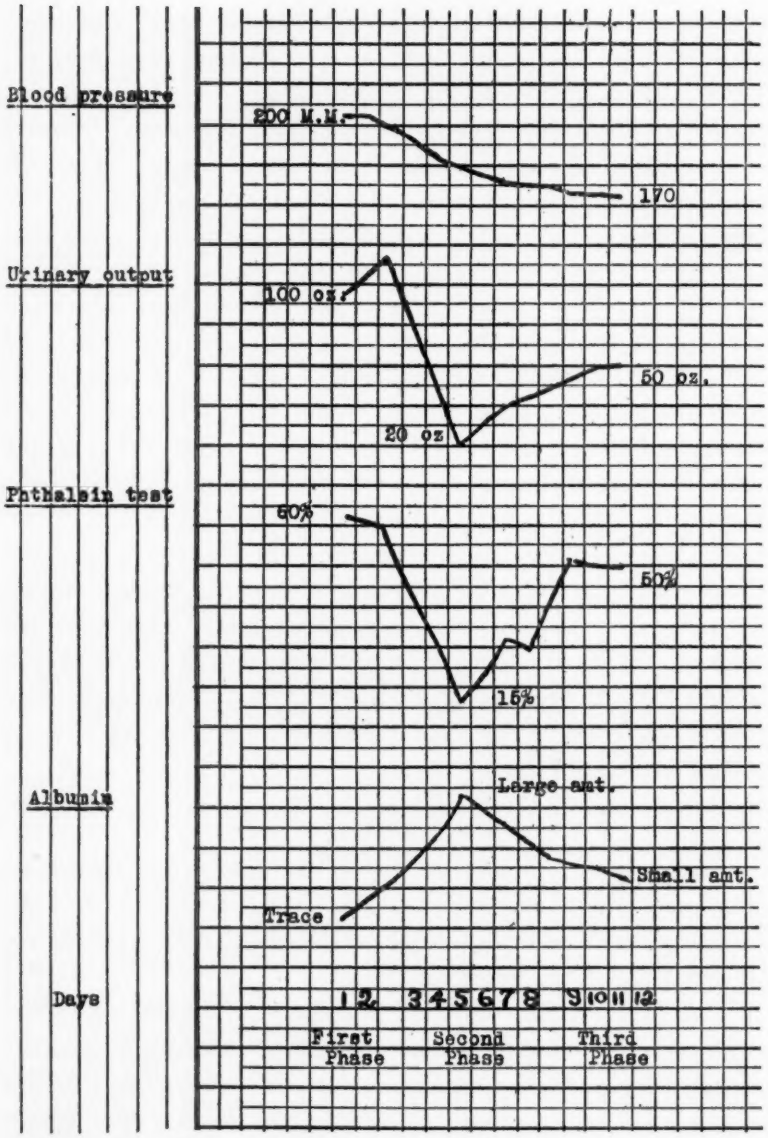


Chart showing the three phases following suprapubic cystostomy in an advanced case of obstruction due to prostatic hypertrophy.

First phase: Includes the first and second day, the suprapubic cystostomy being done on the first day. If one would observe this chart excluding the following days, the conditions would seem to be favorable for any operative encroachment. See page 514. If taken alone, this surely would seem to indicate a safe surgical risk.

Second phase: This phase extends over the third, fourth, fifth and sixth days after a suprapubic cystostomy. It shows a very marked decrease in urinary output during that time,

(Legend continued on next page.)

patient. For example, if the patient's blood-pressure registered 200, was passing 90 ounces of urine in 24 hours with low specific gravity and with only a trace of albumin, we would be rather suspicious of the functional capacity of the kidneys. But when we make a phenol-sulphone-phthalein test, and find that the output in two hours is 60 per cent. or more, it rather leads us to believe that the actual functional capacity of the kidney is greater than the specific gravity of the given specimen would lead us to believe.

The Second Phase.—A second glance at the chart will show a very different condition existing on the third or fourth day after the bladder has been opened and drained. Here we see a lowered blood-pressure, probably between 170 and 180. The urinary output has suddenly dropped to from 15 to 20 ounces in 24 hours; the amount of albumin in the urine has increased enormously and often the urine itself boils almost solid. On the third to fourth day, the phenolphthalein test shows the actual functional capacity of the kidney at this most critical time to be only *15 per cent.* This, then, is the change which has taken place simply following a suprapubic drainage of the bladder without any loss of blood or other surgical shock due to anæsthesia or prolonged manipulation. Add to this, then, the shock of a prostatectomy with its general anæsthesia, a very considerable loss of blood and the shock consequent to pain, and one does not wonder that so many cases have died on the third, fourth and fifth day from no apparent cause which could be demonstrated.

The Third Phase.—Passing on then to the third phase of

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a large increase in the amount of albumin present, but most important of all the drop in functional capacity of the kidney from 60 to 15 per cent.

Third phase: Showing the reaction and the recovery of the kidney after ten days. Blood-pressure 170, urinary output averaging 50, phthalein test 50 per cent., and a smaller amount of albumin present in the urine. Comparing this phase with the first phase we find a lower blood-pressure, a normal urinary secretion with an increased specific gravity, a lowered functional capacity of the kidney, as attested by the phenolphthalein test and a larger amount of albumin present in the urine than during the first phase. When, however, the reaction from this phase following enucleation of the prostate is considered, what a much better combination of circumstances exist in this phase than in the first phase. Following prostatectomy, the blood-pressure falls still lower, due to the loss of blood. The urinary output decreases most markedly during the first 24 hours, but recovers rapidly until, on the third day, it is practically normal. The phthalein test shows lessened reaction, but it never drops as low as was found in the second phase after suprapubic cystostomy, so that 50 per cent. according to the phthalein test in the third phase shows a very much greater relative functional capacity than 60 per cent. in the first phase. This we consider a point of very great importance. The amount of albumin following the operation is an unknown quantity.

the condition following drainage of the bladder, we find in the average case that on the seventh to tenth day the blood-pressure has decreased to from 160 to 170 mm., the urinary output has increased to from 40 to 50 ounces in 24 hours, the phenolphthalein test shows a reaction of the kidney from an output of 15 per cent. to an output of 50 per cent., and the amount of albumin contained in the urine has decreased very markedly, but still shows a small amount present, more than was present before the cystostomy and very much less in amount than was found on the third or fourth day.

Now if the prostatectomy is performed, the effect upon all these phenomena is quite different than was found after the preliminary cystostomy. The blood-pressure falls still lower, the urinary output decreases very little; the functional capacity of the kidney does not fall more than ten points; it is difficult to ascertain the amount of albumin present in the urine on account of the presence of the wound in the bladder, but at no time is it as great as was found on the third or fourth day after the cystostomy was performed.

By following this method we entirely avoid the second phase after the prostatectomy.

This conclusion is based upon the study of our last 28 successive cases, all of which have been operated upon after this method and all of which have recovered. It must be remembered that the second phase will last from a day or two to many weeks, and *if the reaction to the third phase does not take place within ten days to two weeks, the surgeon should not under any circumstances be persuaded to remove the prostate,* because if he does the chances are very much in favor of a fatal outcome. In one of our cases a gastric uræmia developed on the third or fourth day and *it was impossible to remove the prostate for over five weeks.* At the end of that time the third phase of the phenomenon appeared and the prostate was removed without any shock to the patient, followed by uncomplicated recovery.

All clinical observers naturally realize that the different stages vary in many cases as to their extent and their duration.

This point may best be emphasized by the following illustrative cases:

CASE I.—*Diagnosis: Hypertrophied prostate; complete obstruction; vesical calculus; mitral insufficiency; chronic interstitial nephritis; double inguinal hernia.*

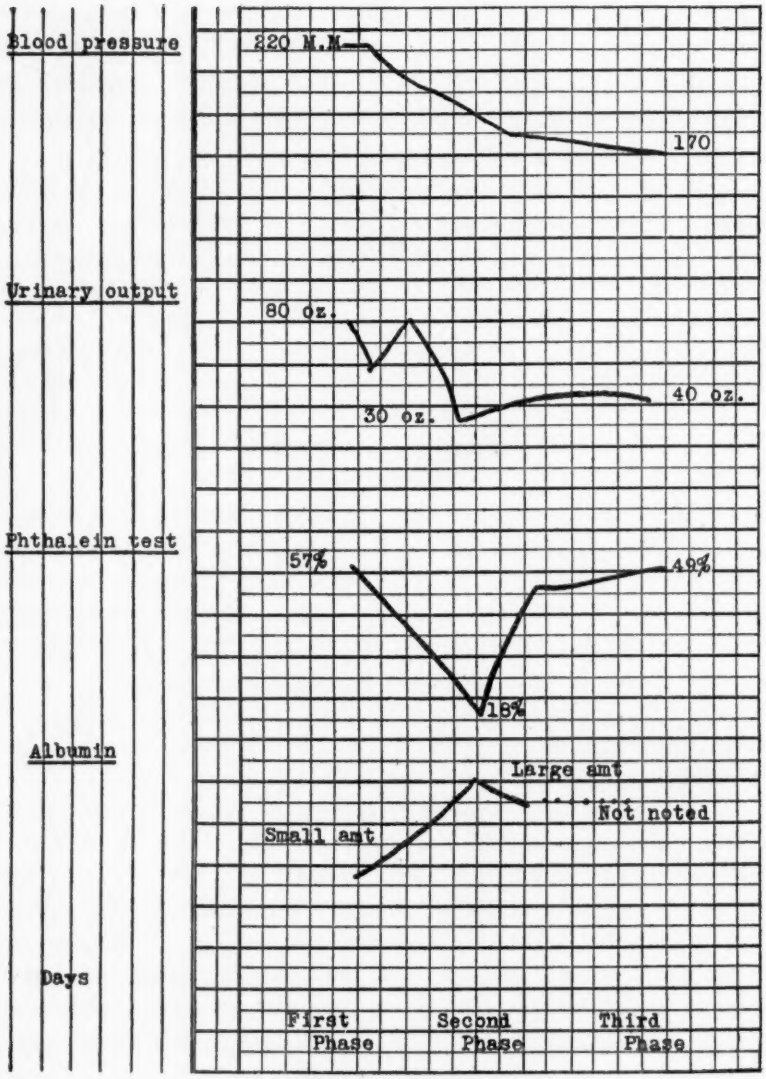
Condition on entrance to hospital July 14, 1913: A large framed man, *eighty-two years of age*, who has led an active seafaring life. For ten years has had increasing frequency of urination and for two years has used catheter daily for the removal of residual urine; *now depends entirely upon a catheter which he uses every four hours.* The use of the catheter is becoming increasingly difficult and painful and has already provoked several attacks of double epididymitis. There is present a moderate cystitis. There are evidences of a generalized *arteriosclerosis* with some *mitral insufficiency* and a moderate degree of *chronic interstitial nephritis.* He has also a *double inguinal hernia.* Notwithstanding these many physical defects, he still presents evidences of considerable vital force and, in the opinion of the surgeons, is a reasonably fair operative risk in the face of the marked urinary crises which are developing. Blood-pressure, 220 mm.; urinary output, 80 oz.; phthalein test, 57 per cent.; albumin, a trace.

First Operation.—On July 15, 1913, a preliminary suprapubic cystostomy was done by Dr. L. S. Pilcher under local cocaine anæsthesia, using 1 per cent. solution of cocaine.

The bladder was exposed in the usual manner without complaint from the patient. Upon opening the bladder a medium-sized *uric acid calculus* the size of a lima bean was detected and removed. A polypoid development of the middle lobe of the prostate perceived. A Pezzer catheter was secured in the bladder and the wound sutured. Patient sustained no shock from the operation. During the following week he remained very comfortable. Urinary output dropped to 30 oz.; phthalein test to 18 per cent., etc. (see Fig. 25). There was a gradual lessening in the blood-pressure and a notable improvement in his general well-being. A phenolphthalein test showed a steady increase in the renal activity.

Consulting the accompanying chart, Fig. 25, it will be seen that the blood-pressure had been reduced to 170 and the functional activity of the kidneys had reacted from the first period of depression. The patient's condition was very satisfactory, despite his

FIG. 25.



THE THREE PHASE CYCLE.

Chart of Case I. Showing the three phases in a patient 82 years of age. Note the marked difference between the three phases—especially the drop from 57 per cent. to 18 per cent. in the renal efficiency and the large increase in amount of albumin. Prostate enucleated during third phase. Recovery.

age of 82 years and his mitral insufficiency and chronic interstitial nephritis. It was, therefore, deemed proper to attempt enucleation of his prostate.

Second Operation.—Transvesical prostatectomy. Under ether anæsthesia, the finger was passed through the suprapubic opening and without removing any of the sutures the prostate was enucleated in three minutes. Some packing of the prostatic pouch was necessary to control a moderate hemorrhage. There was no shock following the operation. Draining tube and packing removed in 24 hours and a Pezzer catheter introduced. The Pezzer catheter removed on the fourth day followed by uninterrupted healing of the wound and full restoration of function. Six months after the operation the patient is quite well and is urinating normally.

It seems quite evident to us that it was safer ten days after the primary operation to remove the prostate than it would have been at the time of the primary operation. With the blood-pressure of 170 instead of 220, with the kidneys relieved of the disorganization incident to retention of urine, and with a well-balanced functional activity, the prostatectomy could be undertaken without danger to the patient. In our series of cases the depression which occurs from the third to the sixth day has been so constant that it is a real factor to be reckoned with in all these cases, and it is our belief that no prostate should be removed until this period of reaction has been passed.

In some cases the second stage lasts two, three, four or more weeks. During this period after the suprapubic cystostomy all of the clinical features of the case preclude the possibility of a prostatectomy and not until a fully developed third stage appears should the prostate be removed. The following case in which the patient developed a gastric uræmia, and massive œdema of the legs, will serve as an example.

CASE II.—*Diagnosis: Obstructive hypertrophy of prostate; gastric uræmia.* The patient was admitted May 9, 1913. General health good. Considerable obstruction. No symptoms of kidney trouble excepting a slight amount of albumin which was present.

First Operation.—Suprapubic cystostomy; Pezzer catheter. May 10, 1913, operation quickly accomplished under local anæsthesia. The day following operation passed 24 ounces of urine, clear, large amount of albumin present; 26 hours after operation

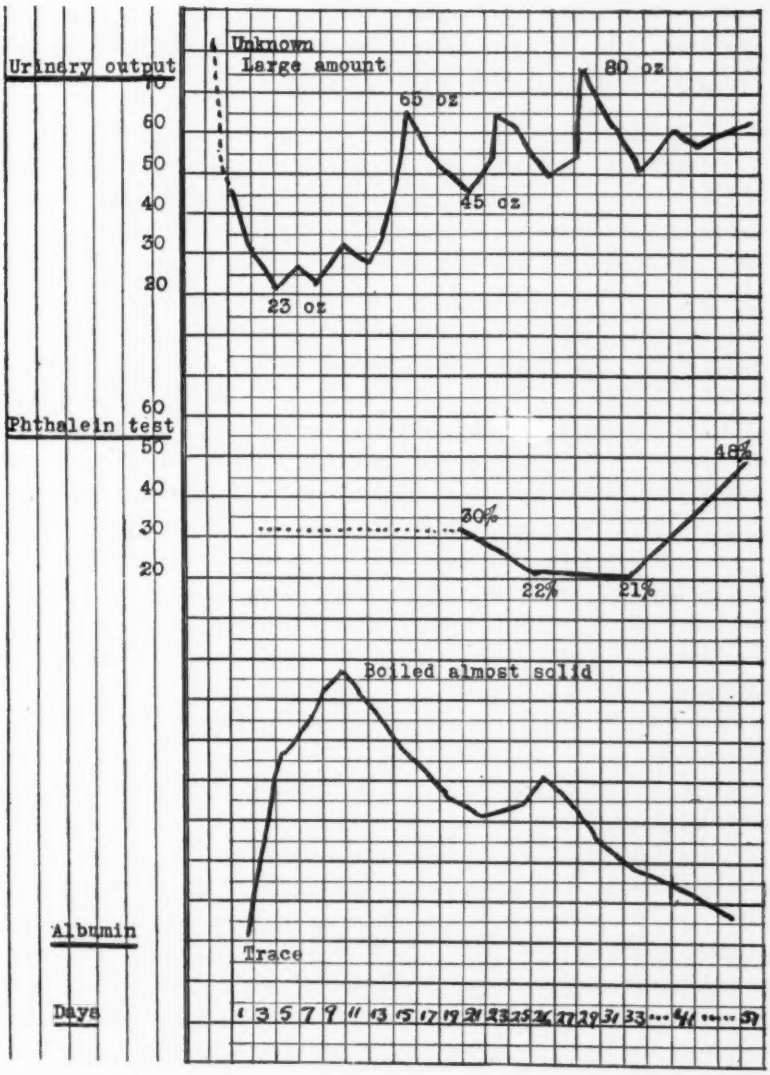
began to vomit; 8 hours after operation hiccoughs began and continued intermittently for 24 hours. Second 24 hours urinary output dropped to 27 ounces, still clear; vomiting continued; urine almost solid with albumin. Third 24 hours some nausea, no vomiting. Fourth 24 hours vomiting recommenced. Hiccoughs lasted for 14 hours, quite restless. Urine became bloody, almost solid with albumin—29 ounces in 24 hours. Fourth day very sleepy, hiccoughs continuing, legs showed slight swelling, urine bloody. Fifth day slight hiccough, urine clearer, sat up. Patient showed a gradual improvement with the exception of the swelling in his legs, which increased so that both legs soon became very badly swollen.

Coincident with this no phenolphthalein test was made on account of the large amount of blood and albumin present. June 2, phenolphthalein test showed 30 per cent. excretion the first two hours; June 9, one week later, showed 22 per cent. excretion first two hours; June 15 showed 21 per cent.; July 1, phenolphthalein test showed the excretion to be 48 per cent. in two hours. The patient's general condition showed a coincident improvement, swelling of the legs entirely disappeared, the amount of albumin in the urine very greatly decreased so a further operation was deemed advisable.

Second Operation.—Transvesical prostatectomy. July 5, 1913. Suprapubic catheter removed and with the finger passed into the bladder through the suprapubic opening the prostate was easily removed. There was considerable hemorrhage which necessitated the introduction of packing. Reaction from the operation was very slight. Twenty-four hours after operation was sitting up in bed; 48 hours after operation the drainage tube was removed from the wound and Pezzer catheter re-inserted; 59 ounces were collected through this catheter during the 24 hours, with hardly any leakage. On the fifth, sixth and seventh days he evidenced some stomach irritability and vomited a little, but the attack passed off quickly. On the ninth day began to urinate a little. Wound healed promptly and the patient was discharged cured August 2.

It is not only the kidney and its function which must be considered, but it may be that it is the heart that is the weak link in the chain, and in order to ensure a safe operation the

FIG. 26.



THE THREE PHASE CYCLE. PROLONGED SECOND STAGE.

First phase: Aside from the large amount of urine passed, the patient's condition was almost ideal.

Second phase: Which followed the suprapubic cystostomy was unusually severe. Marked diminution in the amount of urine. Urine boiled almost solid. Gastric uræmia supervened. Enormous swelling of the legs. Patient in desperate condition. At the end of 51 days, however, all of the uræmia symptoms had disappeared. Amount of urine passed was normal.

Third phase: At end of 50 days phthalein test showed 48 per cent. Urine showed very small amount of albumin. Patient's general condition satisfactory. Prostate enucleated with hardly any post-operative reaction. Patient made perfect recovery.

kidney must be in the best possible condition before the enucleation is undertaken, for if, with a failing, dilating heart the renal function fails, there is little hope for the patient's recovery. The following case illustrates this point:

CASE III.—(Lynch.) Patient was a man whose actual age was sixty-five years although his appearance was that of a man of about eighty. For two years he had been struggling against the ravages of prostatic disease and had gradually become emaciated. Was rapidly losing his strength and had already lost his appetite. He had been catheterized frequently, but this had ceased to give relief and at the time of his examination was passing his water every 15 to 20 minutes day and night. As the result of a metal instrument being passed into the urethra he developed an acute retention with bleeding into the bladder. When seen by me he was in greatest distress and the bladder dilated up to the umbilicus. His pulse was small and weak. He was in considerable shock.

First Operation.—Suprapubic cystostomy. He was hastened to the hospital and immediately the bladder was opened under local anæsthesia, and a large amount of blood clot and urine were brought away and a Pezzer catheter sutured into the bladder and the wound closed around it.

The patient reacted very well from the operation. The following day his temperature reached 102°, his pulse 100, urinary output averaged 25 ounces. Renal sufficiency as shown on accompanying chart, which was 69 per cent. of phenolphthalein excreted during the first two hours immediately after the operation, dropped on the third day to 20 per cent. in two hours under the same conditions. His pulse was weak and soft but not very rapid. His general condition was good. One week later the phenolphthalein test showed an elimination of 48 per cent. in two hours (Fig. 27). Two days after this, when examined, his condition was considered proper for operation, and under ether anæsthesia this was accomplished.

Second Operation.—Enucleation of prostate. Time of enucleation 1½ minutes. Control of hemorrhage, which was considerable, by packing as above described. The day following the operation patient's condition good. Packing and drainage tube removed. Pezzer catheter inserted. Urinary conditions good. On

third and fourth days very considerable cardiac insufficiency, pulse extremely weak, intermittent and general weakness (see chart, Fig. 28); temperature 101.8°, pulse 130, respirations 40. Under

FIG. 27.

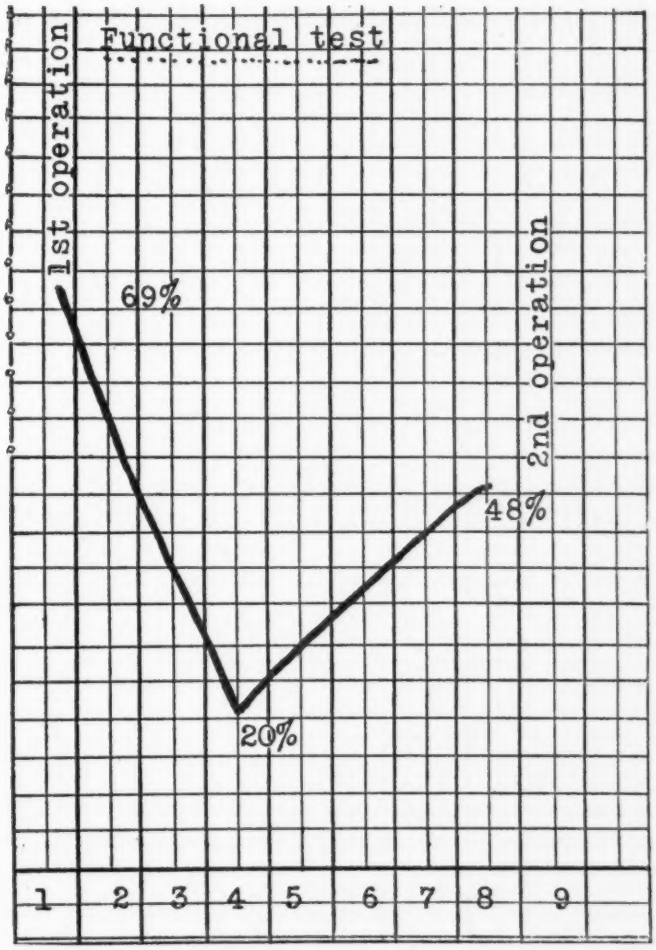


Chart showing drop in renal function during second phase from 69 per cent. to 20 per cent. (Case III.)

proper medication the conditions gradually returned to normal, which they reached on the fourth day. However, this chart will show the dangerous reaction following the operation which, if it had occurred coincident with the shock of the primary operation

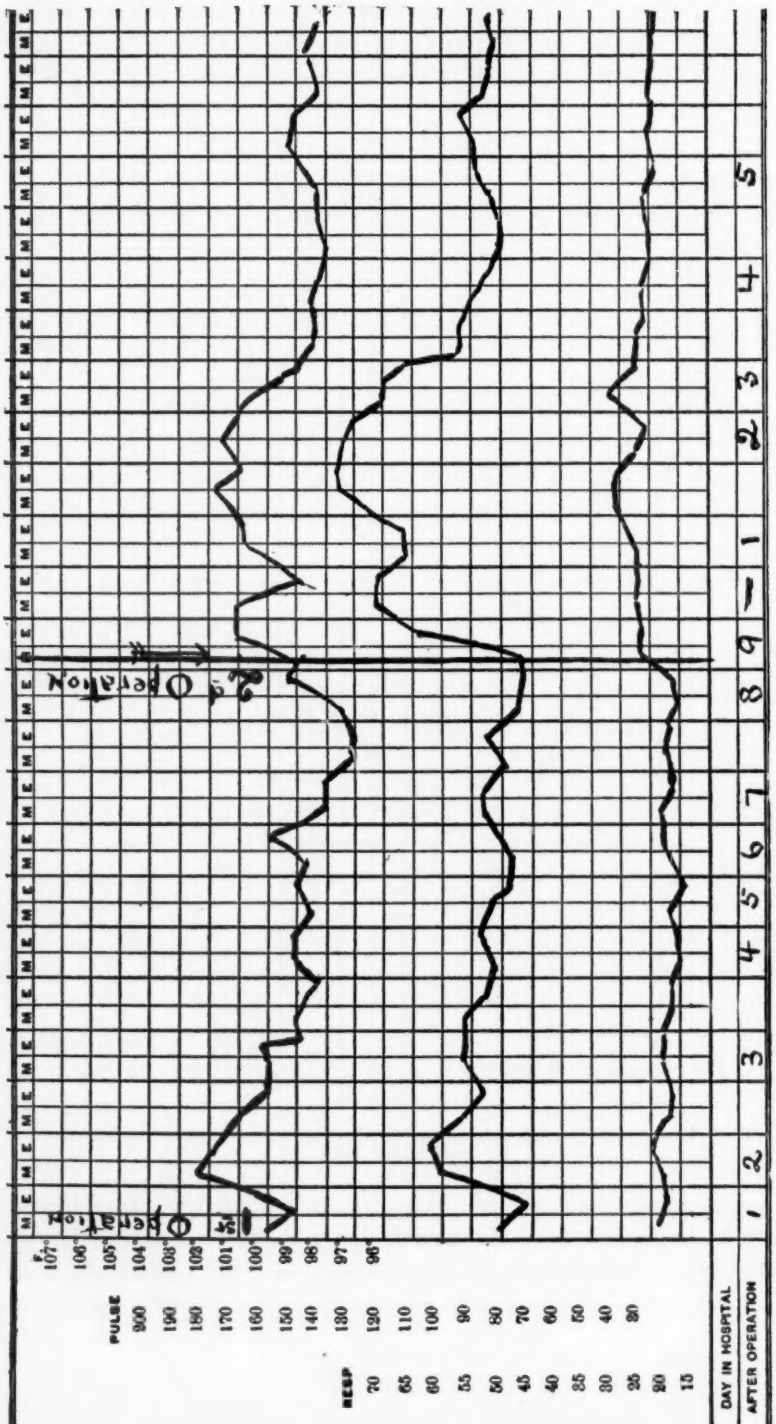


FIG. 28.

Chart showing pulse, temperature, and respiratory conditions in Case III.

with a very marked decrease in the renal sufficiency, the patient would probably have died on the second or third day. As it is the patient recovered entirely; he passed his urine by the urethra on the ninth day, and the wound was closed completely on the twenty-second day. His present condition is satisfactory.

As already referred to, in cases of enormous dilatation of the bladder with œdema of the legs, scrotum, etc., the three-phase cycle shows a remarkable curve when traced on the chart. The accompanying diagram, Fig. 29, shows the condition existing in a patient still under our care. During the first 24 hours the patient passed 249 ounces of urine, a catheter being used to withdraw the amount in small quantities and never emptying the bladder, that viscus being continuously dilated as high as the umbilicus. On the second day more urine was withdrawn at a time and the urinary output was 308 ounces, specific gravity 1002. Following the chart it will be seen that gradually the urinary amount decreased and that on the fourth day the bladder was completely emptied for the first time by catheter, the amount passed during the 24 hours being about 120 ounces. This modified second phase shows a preliminary rise and the enormous output of urine would unquestionably have overwhelmed the patient had a prostatectomy been done, or even a suprapubic cystostomy.

Fig. 30 is the pulse chart of the same patient and shows the remarkable effect the condition had upon the action of the heart. On the twelfth day the phthalein test showed a 40 per cent. output, but the pulse was extremely unreliable. Five days after the suprapubic cystostomy the phthalein test showed an output of 67 per cent. and the pulse at that time would not permit a prostatectomy. In fact, with a heart so badly damaged and a kidney which had been exposed to so much pressure, the date of the prostatectomy must be put off for some weeks.[3] Other cases show only a mild degree of depression in the second phase and it would undoubtedly have been perfectly safe to remove the prostate at the first operation, but as yet I have not

[3] Thirty-eight days after the cystostomy the prostate was removed and the patient has made a good recovery.

FIG. 29.

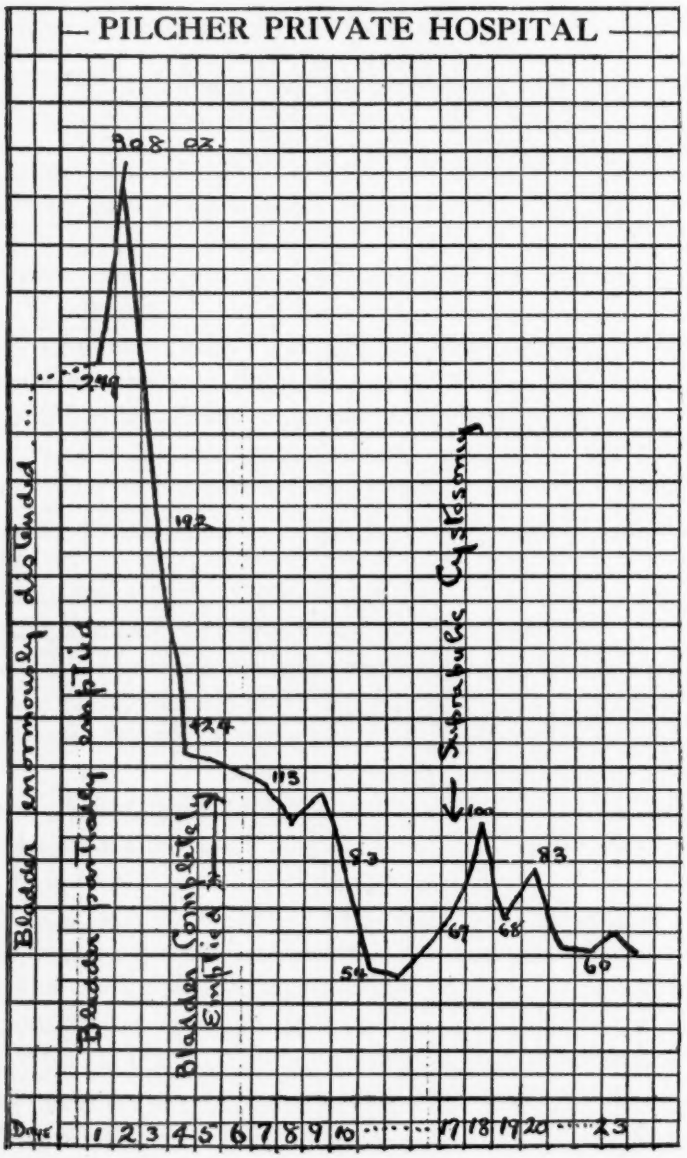


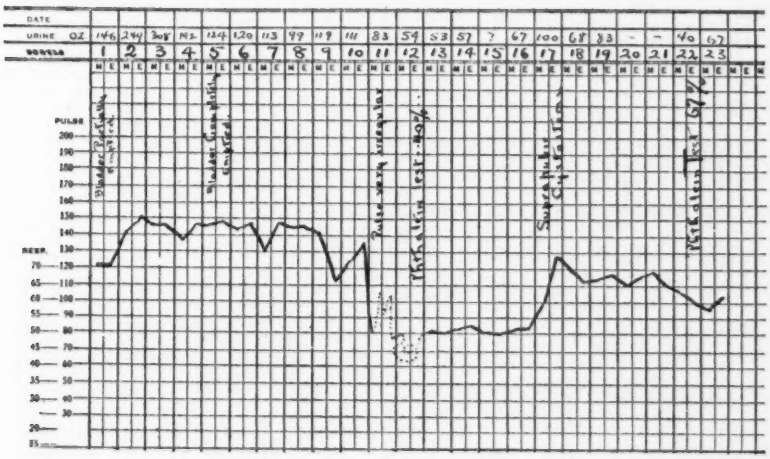
Chart showing remarkable first phase of chronic prostatism. Bladder distended above umbilicus. Patient in collapse. Partial decompression of kidney developed urinary output of 308 ounces of urine in 24 hours. The second phase showed a gradual drop in urinary output, with a very marked increase in the amount of albumin. Suprapubic cystostomy on twelfth day showed very slight reaction from kidney. For the first twelve days, urine was removed by catheter.

been able to tell which cases fall within this class until after the cystostomy has been performed.

How shall we decide, then, when it is safe to remove the prostate in a given case?

First, our judgment is based on the general condition of the patient. When his appetite returns and his sleep becomes normal, when his temperature, pulse and respiration are nor-

FIG. 30.


DATE
URINE OZ
146 244 348 112 124 120 113 99 119 111 83 54 53 57 7 67 100 68 83 - - 40 67
BOWELS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E M E
PULSE
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Bladder Partially emptied
Bladder completely emptied
Pulse very irregular
Phthalein test 80%
Supra Pubic Cystostomy
Phthalein Test 67%

Pulse chart of same patient whose urine chart is shown in Fig. 29. Partial emptying of the bladder caused pulse to rise to 150 beats per minute. On the eleventh day heart action changed suddenly, as indicated on the chart, and its rhythm and rate were very irregular. The heart balance was gradually established and the suprapubic cystostomy did not disturb it very much.

mal, and when the renal output has returned to normal limits, we consider these a fair index of the general physical well-being of the patient.

Second, we do not advise prostatectomy until all the gross uræmic and nephritic symptoms have disappeared. A moderate amount of albumin in the urine is no contra-indication. The condition of the blood-pressure is also a valuable index.

Third, the phenolphthalein test is of value only as taken in connection with other signs. In the first place, one must consider the results of the phthalein test before the preliminary cystostomy; then the phthalein test taken on the second, third

or fourth day, and third, the functional reaction of the kidney to this test at the end of a week or ten days. It is a mistake to rely entirely upon this test, especially before the cystostomy has been done. For example, the test may show excretions of more than 50 per cent. in the first two hours before the preliminary cystostomy, but the reaction may drop on the second or third day, after relief of the retention of urine, to below 15 per cent., which is a true index of the functional capacity. When, however, the period of depression is passed and the reaction returns to 50 per cent. after the retention of urine has been relieved, this then becomes a fair index of what we can expect the kidney to do after the prostate has been removed.

CATHETER DRAINAGE OF THE BLADDER.—There are some cases in which catheter drainage of the bladder must be used as a preliminary to the suprapubic cystostomy, such as cases where there is an enormous distention of the bladder with œdema of the legs, scrotum, and penis due to pressure. If a cystostomy is done and all of the urine is withdrawn at one time from the bladder, the shock and decompression of the kidney thus occasioned may bring on a fatal uræmia or a fatal hemorrhage. One such case was seen by the writer at the Jewish Hospital in Brooklyn where the bladder, which was enormously distended, was suddenly emptied; the patient promptly died. A second case under the care of the writer at St. John's Hospital, in which 72 ounces of urine was withdrawn from the bladder, was followed by a dangerous hemorrhage into the bladder.

1. *Indications for Catheter Drainage.*—Some operators prefer to use catheter drainage for a week preparatory to every transvesical prostatectomy. It is always indicated in cases where the residual urine amounts to 30 ounces or over.

2. *Dangers.*—Sudden withdrawal of all of the urine may cause death from shock, uræmia or hemorrhage. The presence of a catheter in the urethra may occasion infection, and in a number of reported cases death has followed its use.

3. *General Rules.*—If catheter drainage is established, the bladder should not be emptied all at once, but the urine grad-

ually withdrawn and, depending upon the amount present and the amount secreted by the kidney, the amount drawn should be regulated.

It is an interesting fact that the control of the amount of residual urine in cases of enormous distention of the bladder will regulate the output of urine through the kidney. In connection with these cases no drugs should be given to stimulate the heart or change its action until there is some very absolute indication for the same, for harm may be done, preventing the establishment of a normal balance, as the heart adjusts itself to the new conditions found in the kidney.

IV. SUPRAPUBIC CYSTOSTOMY.

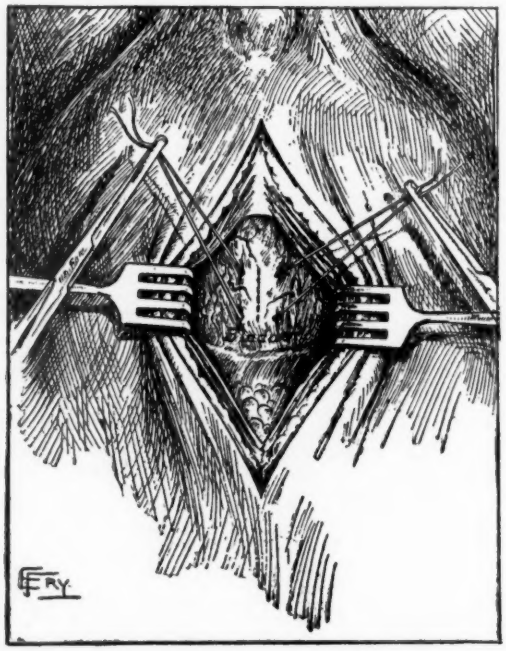
First step, preparation of the patient. Skin, usual iodine preparation. Anæsthesia, novocaine 2 per cent. by preference. Incision, vertical.

Technic of Operation.—Usual incision beginning just above the pubis is made through the skin and superficial fascia. The sheath of the rectus is divided in the median line, the recti muscles are separated, exposing the prevesical fat and fascia. The muscles are held apart by a specially devised retractor, modified from the Mayo-Collins appendectomy retractor. The advantage of this retractor is that the curved blades are in a straight line at the point where they enter between the muscles, and after they are entered they present a concave surface to the muscular face which they wish to retract, which keeps them from slipping out of the wound. Then the third arm of the retractor is placed later. When the prevesical space has been exposed, the finger is entered until it reaches the superior surface of the symphysis. With this as a landmark, the finger covered with gauze is used to strip the fascia and lymphatic tissue from the anterior wall of the bladder. It is often of advantage to have the bladder partially filled with water, for then it is somewhat easier to clean off the anterior surface of the bladder with the finger. This stripping away of the tissue with the finger is carried up to the peritoneal fold. The peritoneum is not disturbed unless it

reaches far down over the anterior surface of the bladder. If this is so, the peritoneum is stripped up somewhat. With the bladder surface freely exposed, the third arm of the retractor is placed over the bit of gauze to hold up the fat covering the peritoneal fold.

Securing the Bladder.—To hold the bladder in place a silverized catgut retention suture is passed through the wall of

FIG. 31.



Second step in the preliminary cystostomy. The bladder wall is seen exposed and the position of the incision is indicated near the fold of the peritoneum. The two stay sutures are in place and hold the bladder wall up. As soon as these sutures have been introduced the fluid is withdrawn from the bladder.

the bladder near the point at which the bladder is to be opened (Fig. 31). The water is then withdrawn from the bladder through the catheter and the bladder washed clean. Then holding the wall of the bladder out through the abdominal wound, a knife is thrust into the bladder. The knife is withdrawn and the finger enters the bladder and examines the interior of the bladder to determine the presence of stone or

any foreign body. A foreign body, if present, is then removed. The condition of the prostate and its conformation and general character is then studied with the finger. The only point at which the patient will complain of pain is when dragging on the bladder wall or when examining the bladder with the finger through the bladder wound. Examination of the interior of the bladder can be done quickly. The finger is then withdrawn and a Pezzer catheter is inserted into the bladder wound (see Figs. 32 and 33).

The Point at Which the Bladder is to be Opened.—Incision into the bladder is made as near the peritoneal fold as possible, for healing takes place more rapidly at this point, and when a fistula is formed, the urine enters the fistula less easily at this point.

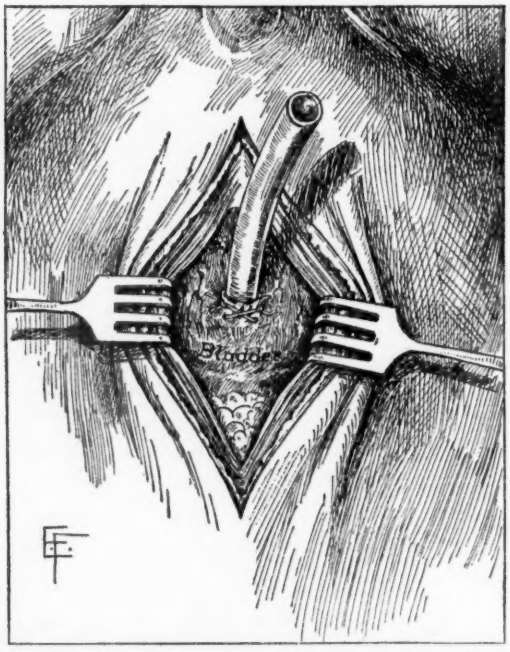
Draining the Bladder.—The Pezzer catheter, as mentioned before (Fig. 33), is fixed in the anterior wall of the bladder, then, using the same suture that was placed for the retraction suture, a purse-string is made in the bladder wall around the catheter. This suture is of catgut. It is tied, being careful to tuck in the muscular wall of the bladder around the catheter. This produces a slight spur in the interior of the bladder which, after the catheter is removed, favors early healing. This suture when tied insures a water-tight joint around the Pezzer catheter. The wound is then reconstructed. The prevesical space is carefully obliterated by the catgut suture. The fascia and muscles are sutured together with chromic gut. The skin is sutured with silk. In other words, all of the planes of tissue are brought together again in their natural position and the only opening is the line through which the catheter emerges. It is possible to do this in these cases because the joint around the Pezzer catheter is water-tight and there will be no leakage for over a week. The result is that *we have a primary union of the wound, a thoroughly drained bladder and the first step of our transvesical prostatectomy already completed.*

In any transvesical prostatectomy most of the time will be consumed in making the suprapubic incision and in closing

the same. By this method this step of the operation is already completed before the prostatectomy is attempted.

Whatever shock is going to take place from this encroachment on the urinary apparatus in cases of prostatic hypertrophy will become evident on the second to the fifth day after the suprapubic cystostomy. The *patient is in the best possible con-*

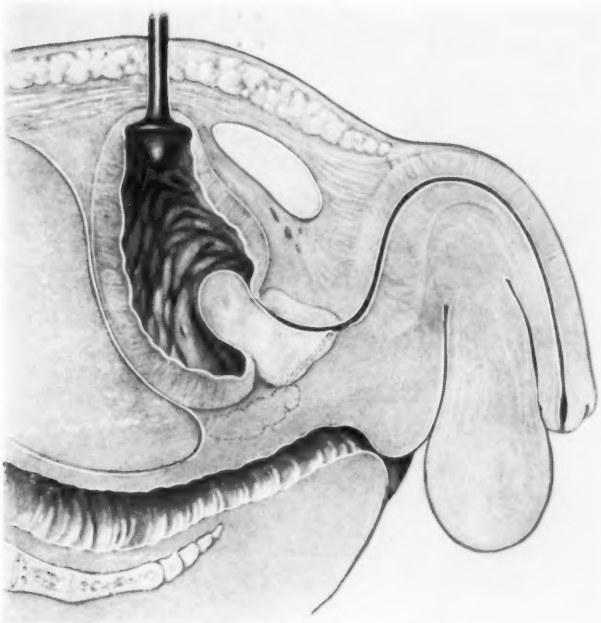
FIG. 32.



Shows the way in which the Pezzer catheter is fixed into the bladder wound,—the stay suture from one side being tied on the opposite side of the tube including some of the bladder wall, and the one from the other side tied in a similar manner. These will hold the tube firmly in place. A purse-string suture is used for the same purpose.

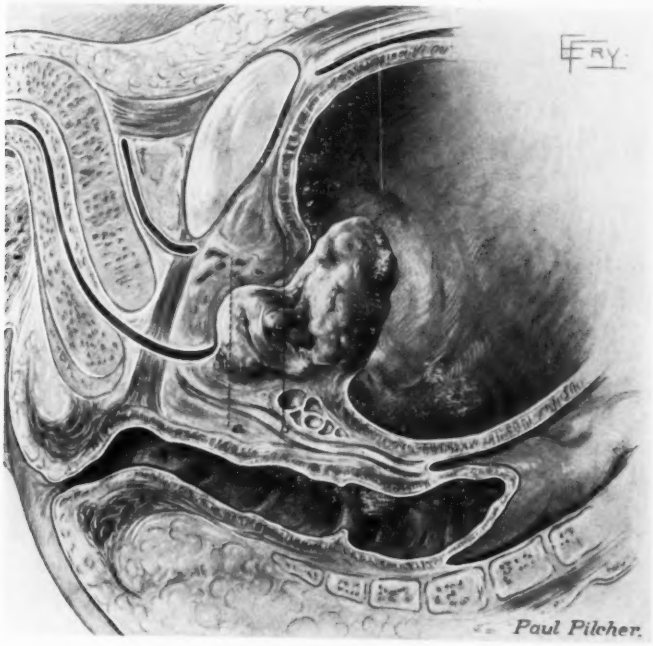
dition to overcome this shock because there has been no loss of blood, no general anæsthetic, and *no special pain,* all of which factors tend to decrease the resisting powers of the organism. Almost without exception in cases where there has been any great retention, there is a marked renal reaction which occurs during the first week, as previously noted. If this, then, can be eliminated as a factor of the prostatectomy itself, it seems to us that it is our duty to do this.

FIG. 33.



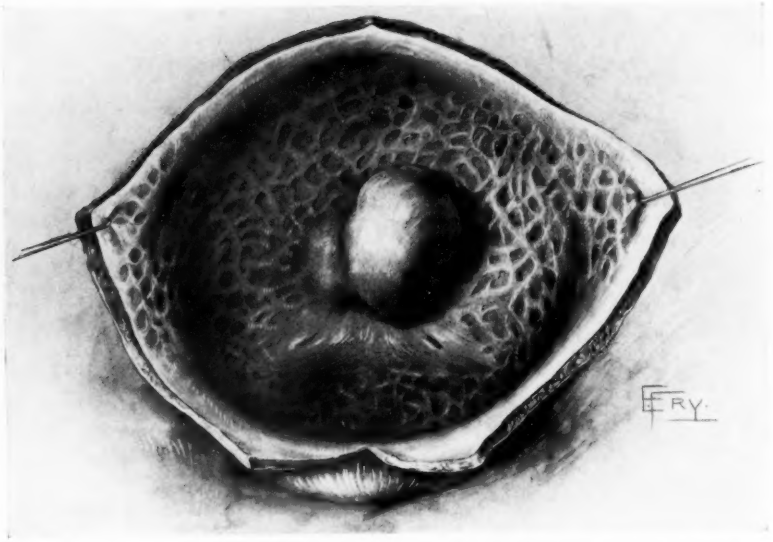
Pezzer catheter in place after suprapubic cystostomy. Button of the catheter fits snugly and is far superior to the ordinary drainage tube inasmuch as it does not permit any rough or sharp surface to irritate the prostate or the bladder wall. This idea was first suggested to me by Rovsing and is the method which he follows.

FIG. 34.



The surgical problem. The picture presented illustrates the average case of prostatic hypertrophy with a special development of the median lobe. It is shown to emphasize the bearing of the surgical pathology upon the choice of method of operation.

FIG. 35.



Illustrates a second view of the vesical aspect of a hypertrophied prostate showing the irregularity of the outgrowth and emphasizing the fact that the prostatic hypertrophy is a lesion of the bladder and not of the perineum.

Two other methods have been devised as the first step of the transvesical enucleation. First, the use of a permanent catheter. This question has already been discussed (p. 528). The objections to it are: In the first place, it is most disagreeable to many patients; in the second place, it almost invariably excites a urethritis which frequently causes an infection of the epididymis, and sometimes affects the testicle. These are unfortunate complications. In the third place, fatal sepsis has more than once followed the using of a permanent catheter in old men with prostatic disease.

One method used as a substitute for the suprapubic cystostomy in emergency cases is the puncture with a trocar above the pubis. This is not without danger in the hands of some surgeons, to say the least, and it does not in any way shorten the major operation.

My chief argument, however, is that by doing a preliminary suprapubic cystostomy we accomplish everything that any of the other methods do; we are able to do it under a local anæsthetic; we have exposed the suprapubic tissues to infection and, if this takes place, which is a very rare occurrence in these cases, it may be overcome and will subside before enucleation of the prostate is undertaken. Again, as the result of the preliminary cystostomy, the œdema and swelling around the neck of the bladder, including the prostate, greatly diminish. I have seen the prostate diminish one-half in size after the suprapubic cystostomy alone. This is of advantage in the enucleation and the healing of the wound.

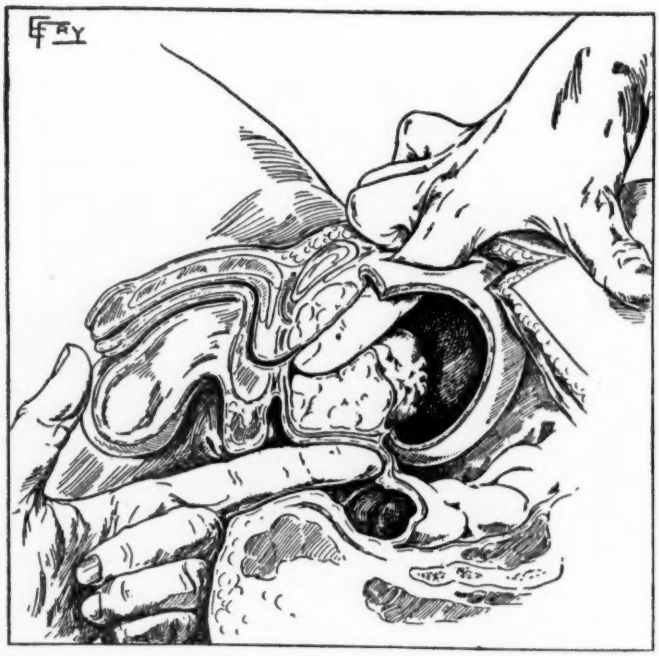
V. THE TECHNIC OF TRANSVESICAL PROSTATECTOMY.

When it has been proven to the surgeon's satisfaction that the prostate can be safely removed, judging from the functional test of the kidney compared with the original functional test and taking into account the amount of urea excreted and the evidences of acute or chronic renal disease, as well as the general condition of the patient, as previously stated, the operation may be undertaken. The patient is prepared as for any other operation. When the dressings are removed, after

the preliminary cystostomy using the Pezzer catheter, it will be found that the wound surrounding the catheter has healed by primary union. *The silk sutures are still in place. These are not removed,* for they are needed to hold together the recent wound while the finger is enucleating the prostate.

First step: The skin is prepared with iodine. The Pezzer catheter is removed and the *gloved finger* introduced into the

FIG. 36.



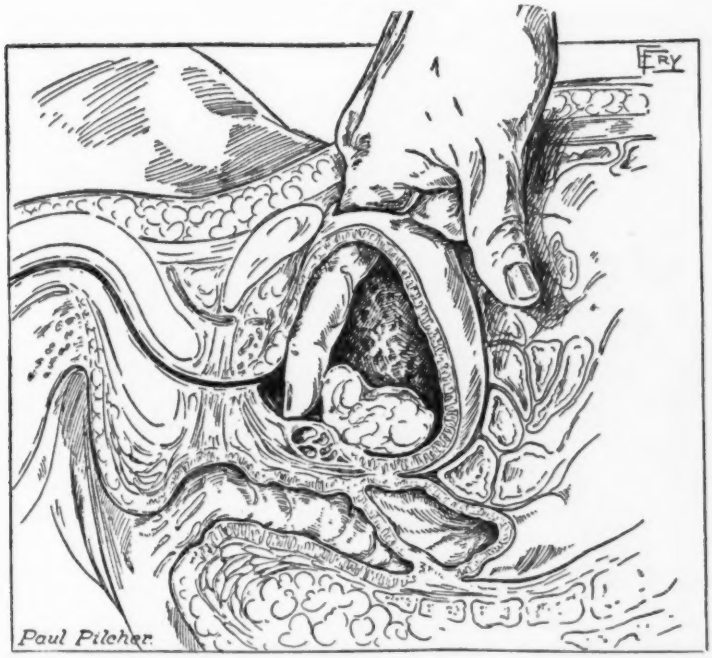
Transvesical prostatectomy. Enucleation of the prostate. Usual method. Finger is introduced into the urethra and advanced as far as possible before breaking through the urethral mucous membrane. Usually the line of cleavage is easily found from the urethra and the enucleation is accomplished as described in the text.

bladder through the suprapubic opening. This opening easily dilates sufficiently to allow free manipulation of the finger. The index finger of the other hand is introduced into the rectum and the prostate is lifted up.

Second step: Enucleation of the prostate. The index finger of the enucleating hand is introduced into the prostatic urethra and advanced as far as possible, reaching, if possible, the furthest point of the prostatic enlargement. This method,

as shown in Fig. 36, is especially useful in two forms of prostatic enlargement, that which is due to an irregular enlargement of both lateral lobes, and that which is due to enlargement of both lateral lobes and the median lobe, even though the median lobe be enlarged out of all proportion to the other two lobes, as in Fig. 3. With the finger in the prostatic urethra, the point of least resistance in the mucous membrane of the urethra is sought. Usually this will be found on the lateral or the antero-

FIG. 37.

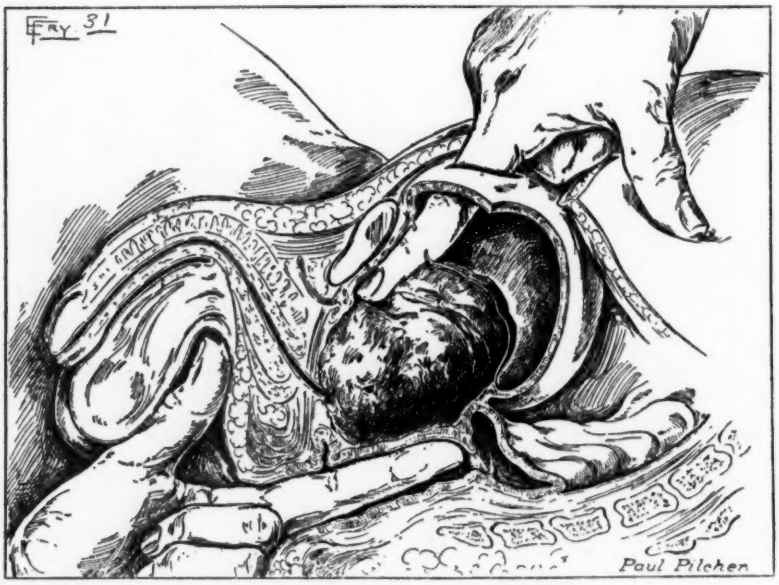


Drawing illustrating one of the final steps in enucleation of the prostate. The lateral lobes have been freed and the mass together with the median lobe is being turned over and turned into the bladder, stripping up the mucous membrane of the bladder from the surface of the prostate.

lateral wall of the urethra. At this point the division between the prostate and the urethra is usually quite easily broken through. In all of my recent cases I have been able to gain the line of cleavage through the urethra easily with the gloved finger. The finger after entering the line of cleavage sweeps, first, slowly around the distal portion of the growth, and then, up over the anterior surface of the growth separating it from

the prevesical tissue. The finger is then passed across the urethra to the other side with a sweeping motion of the finger and the opposite lateral lobe is freed. Then passing the finger up over the entire mass an attempt is made to turn the growth over so that it will easily turn out into the bladder carrying with it the median lobe (Fig. 37). That is to say, the finger is passed up over the two loosened lateral lobes and then beneath the same between the enlarged lobes and the rectum, and then

FIG. 39.

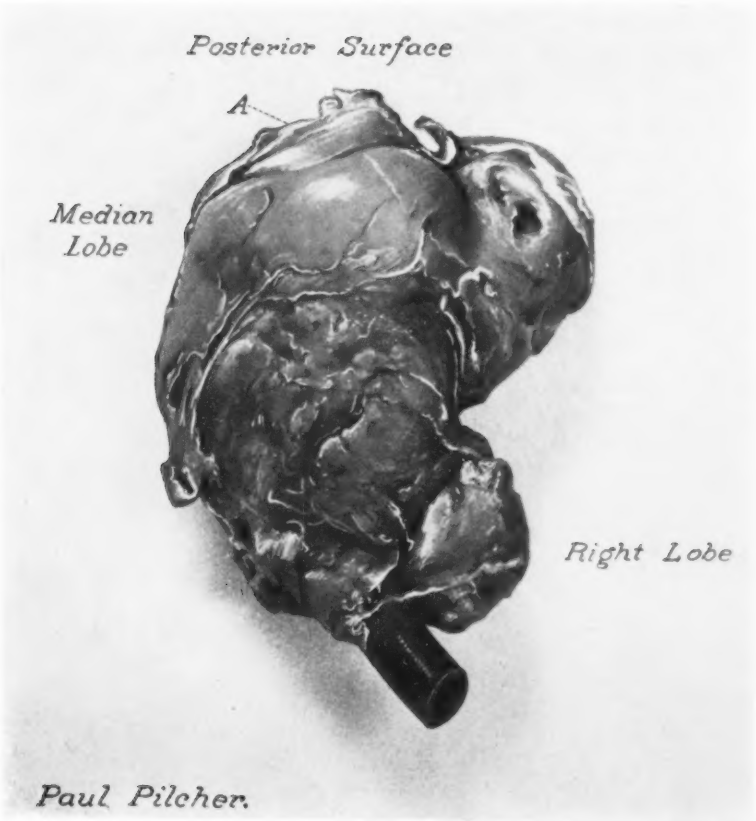


Drawing illustrating method of removing a massive hypertrophy of the prostate where the urethral enucleation is impracticable. This is applicable in the large bilateral hypertrophies. The illustration shows the finger raising up the sphincter, enucleating the prostatic mass in one piece.

the finger is pulled toward the bladder so that the growth will turn upon itself, as is shown more clearly in Fig. 37.

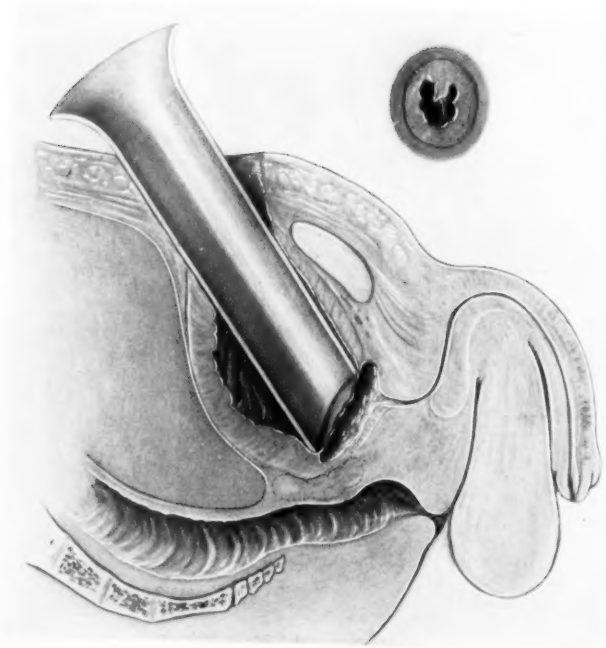
As the growth is turned out into the bladder, the bladder mucous membrane will be stripped up from the posterior side of it, as may be seen in Fig. 38. The point which is most difficult to free is the attachment at the junction of the prostatic and membranous urethra, which is seemingly a fibrous attachment, or may be the attachment to the atrophied posterior lobe which lies distal to the ejaculatory ducts and which prob-

FIG. 38.



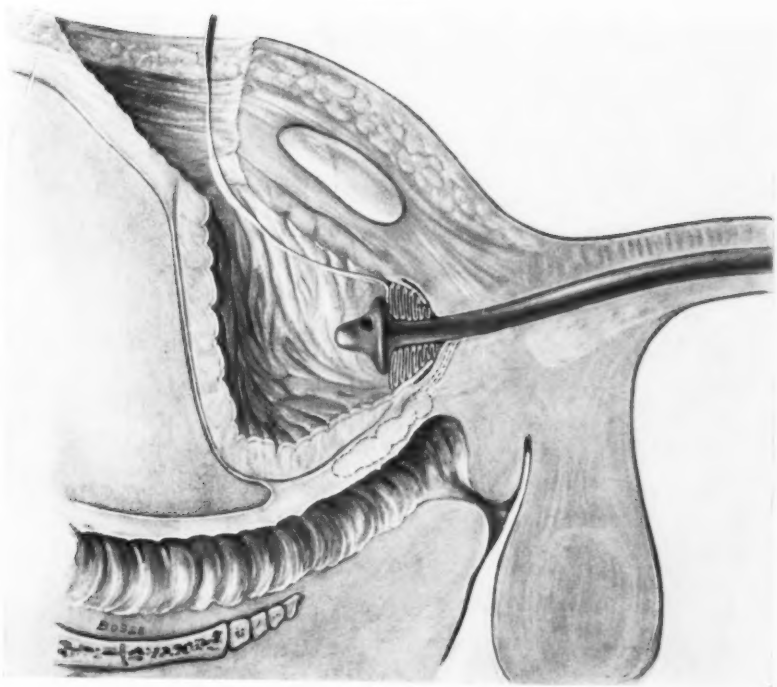
Under surface of prostatic mass showing the enormous median lobe and the small right lobe. "A" shows the torn edges of the mucous membrane stripped up from posterior surface.

FIG. 40.



Illustrating the method used by Fenwick to control hemorrhage after prostate had been removed. Small picture in upper right hand corner shows condition frequently found for a small blood-vessel which seemed to be bleeding, contained in the torn edges of the bladder mucous membrane. Illustration shows the speculum in place with the neck of the bladder exposed, that the operator may directly clamp any bleeding vessel. This method in the hands of Fenwick is ideal.

FIG. 41.



Showing method of controlling hemorrhage by the use of packing. The Pezzer catheter is introduced by first passing a silver catheter through the urethra and out through the supra-pubic wound attaching the Pezzer catheter to the silver catheter and withdrawing same through the urethra. When the Pezzer catheter is in place, the packing is inserted, consisting of narrow gauze, introducing it in such a way that the torn mucous membrane flaps of the bladder are pushed ahead of the packing and when the packing is in place the Pezzer catheter is pulled down, keeping the packing in place and exerting pressure against the bleeding surface at the same time. In order to hold the Pezzer catheter firmly in place, it should be attached to the leg by adhesive plaster. The gauze is removed after 24 hours and the catheter at will.

FIG. 42.

Appearance of suprapubic scar two weeks after the operation. It is meant especially to show the clean appearance of the wound which is entirely free of incrustations or sloughs.

ably is not removed in the majority of cases. It has been our experience that *those cases in which the prostate does not shell out easily should be carefully examined for evidences of malignancy.*

The other type of prostate which is occasionally met with is the enormous prostate which seems to be hypertrophied in all its parts with the exception of the median lobe. Such a prostate is seen in Fig. 12. In removing this prostate it may often be more completely and more easily done by passing the finger between the sphincter vesicæ and the growth itself and sweeping the finger around the growth, as recommended by Freyer. It will quickly fall out into the bladder. This method of enucleation is illustrated in Fig. 39. However, in the majority of cases the intra-urethral enucleation is to be preferred. It is quite essential for the welfare of the patient that all of the prostate as far as possible shall be removed. Thus, Fig. 6 shows a prostate with a very large median lobe and two moderately enlarged lateral lobes, with many pieces of prostatic tissue which were dug out from the capsule after the main growth had been removed. The operator should never be satisfied with removing the larger adenomatous mass alone, but an attempt should be made to bring away all the prostatic tissue possible unless there is a diffuse carcinomatous involvement. If fragments remain, they retard the healing of the cavity from which the prostate has been removed and are apt to necrose and cause a delay in the healing of the bladder.

Third step: Removing the prostatic sections and the blood clots from the bladder. A pair of forceps is passed through the suprapubic wound and the pieces of prostate which have been turned out from the bladder are carefully removed. All of the blood clots in the bladder should be washed out so that no pieces of foreign material are left behind.

Control of the Hemorrhage.—A number of methods have been devised for controlling the hemorrhage.

First, the Fenwick method by clamp and ligature. Fenwick has devised a series of three specula of different sizes which may be introduced through the suprapubic wound, bringing

the area from which the prostate has been removed directly into view. The use of one of these speculum is illustrated in Fig. 40. The headlight is used to illuminate the cavity. With the lacerated oozing area in view and properly illuminated, the area is sponged as dry as possible and it will be found, as a rule, that *bleeding does not come so much from the cavity from which the prostate has been removed, but usually from the free edges of the lacerated tissue* which covers the surface of the prostate on its vesical aspect. This was very beautifully demonstrated to the writer by Mr. Fenwick himself. In one case he was able to show me a spurting vessel in this free edge. He demonstrated further that the area from which the prostate has been removed flattens out very quickly and does not remain as a cavity, but retracts down and, as a rule, does not allow space for the accumulation of blood clots. Through the speculum the bleeding points are caught with specially devised hæmostats. In this way, as a rule, the bleeding can be entirely controlled. In most cases after a few minutes crushing with the hæmostats they may be removed and no further bleeding will occur. The hæmostats are so constructed that the handles may be removed, if necessary, and left *in situ* for 24 hours.

As a modification of this method, the writer would suggest the use of the actual cautery through the speculum to control any bleeding point which might come into view.

Second, control by suture. A number of prominent operators complete their prostatectomies by surrounding the area from which the prostate has been removed by a continuous catgut suture. This necessitates a large suprapubic wound and consumes considerable time and, in the experience of the writer, has never been found necessary.

Third, control by pressure. With one finger in the rectum and a finger in the bladder the tissues involved in the prostatic wound may be pressed together and in this way much oozing will be prevented. At the last meeting of the American Urological Society in Boston, April, 1913, the writer presented a method of controlling hemorrhage, using gauze packing.[4]

[4] Pilcher: *Transactions of the American Urol. Soc.*, 1913, vol. vii, p. 57.

This consists of introducing a catheter through the urethra which serves as a guide and centre around which the packing is to be placed. Then a narrow strip of gauze packing is introduced through the suprapubic wound and the torn edges of mucous membrane which have been stripped up from the prostate are pressed down into the shallow prostatic pouch and held in place by gauze packing, as is shown in Figure 41. This shows the prostatic pouch exaggerated with the torn flaps of mucous membrane pushed before the gauze packing and in addition the Pezzer catheter used to hold the gauze packing in place. This Pezzer catheter may be introduced by first passing a silver catheter through the urethra and out from the suprapubic wound and then attaching the small end of the Pezzer catheter to the silver catheter and drawing it out through the urethra. With the expanded end of the catheter on the vesical side of the packing, considerable pressure may be brought to bear, using a very small amount of gauze packing by pulling on the penile end of the catheter. Up to the present time we have always used the simple rubber catheter as a guide and centre around which to pack the gauze. The end of the gauze is led out through the abdominal wound (Fig. 41). Other methods of controlling hemorrhage by direct pressure have been devised, but none of them are superior to those which have been mentioned.

Control of Secondary Hemorrhage from the Bladder.—*Hemorrhages occurring within 12 to 24 hours* after the prostatectomy are best controlled by packing the prostatic pouch around a catheter introduced through the urethra. In one case the writer passed a silk suture through the perineum, placed a gauze packing over the prostatic pouch and fastened the silk suture to this gauze packing, tying the same on the outside of the perineum. *Secondary hemorrhage which occurs a week or so after the operation* may be either from the wound itself which calls for re-opening the wound and suture, or may be from the vesical neck or the prostatic pouch itself. Such an occurrence calls for re-opening of the bladder, exposure of the bleeding point and securing same either by suture, the actual

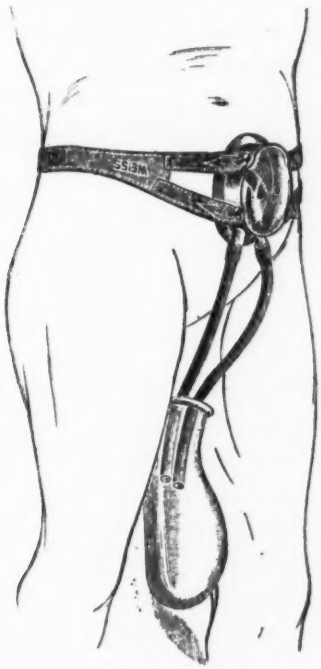
cautery or the high-frequency spark generated from the D'Arsonval current. In one case of my own, it was necessary after the second week to re-open the bladder widely and cauterize the entire area of the vesical neck before the hemorrhage could be stopped.

Drainage of the Bladder After Transvesical Prostatectomy.—To the mind of the writer, it is very *essential to drain the bladder suprapubically after every case of prostatectomy.* We consider it dangerous and unnecessary to run the risk of closing the bladder after transvesical prostatectomy. This has been emphasized in our own experience in two cases in which we closed the bladder and were compelled to re-open and drain the bladder on account of severe hemorrhage within the bladder which clogged the urethral catheter. Our routine is, as soon as the prostate is removed and the hemorrhage checked, to introduce a large rubber drainage tube, one inch in diameter, just within the wall of the bladder, and after securing it in place to apply copious gauze dressings over the same. If the packing of the prostatic pouch is necessary, a small gauze packing is brought out through the large drainage tube. It should be emphasized at this point that none of the silk skin sutures introduced at the primary operation have been removed, and that after the enucleation of the prostate no suturing of the wound is necessary. The cystostomy wound made at the first operation is capable of very great distention without tearing it open if the original sutures have not been removed.

After-treatment.—As soon as the patient has been returned to his bed a proctoclysis of tap water is begun and the abdominal dressings changed as frequently as necessary. *After 24 hours* the bladder is irrigated through the suprapubic tube which is still in place. If packing is in place it is removed, together with the large suprapubic drainage tube. The Pezzer catheter replaces the suprapubic drainage tube. It will be found that in six to eight hours the bladder wall will contract around the Pezzer catheter and very little urine will leak out beside it. The Pezzer catheter is left in place for three or four days until the wound surfaces have healed over. This tends to pre-

vent the formation of sloughs and phosphatic concretions on the wound surfaces (Fig. 42). Also, the use of drugs to prevent alkalinity of the urine will tend to give a better wound. *On the fourth or fifth day* the Pezzer catheter is removed and is replaced by a collecting device of an English maker, which is shown in Fig. 43. The wound is strapped with a piece of inch-wide adhesive tape and what urine escapes is

FIG. 43.



collected in the celluloid cup and drains from the cup into a bottle through a rubber tube. This ingenious device is held in place by rubber straps which keep it from slipping. It is a very convenient and comfortable adjunct to the convalescence. If the suprapubic cup is not available, the use merely of masses of absorbent gauze over the fistula will answer any need until the fistula closes and normal urethral urination is re-established.

The period of healing of the suprapubic wound has in our experience taken from one week to four weeks, *the average be-*

ing about 16 days. In none of our cases has there been any permanent suprapubic fistula. The nearest approach to it was in the case of recurrent secondary hemorrhage in which the bladder was twice widely opened in order to control the hemorrhage. In one case the suprapubic wound closed in four days.

Control of the Urine.—About the eighth to tenth day, as a rule, small amounts of urine will pass *per urethram,* the amount increasing as the suprapubic wound contracts. It is worthy of note that in none of our recent cases has dribbling been noticed, and that within two or three weeks after the operation the patients have fairly good control, and in all the cases operated upon by us after this method the result has been full control of the urine with complete emptying of the bladder.

Potency of the Male.—This operation does not seem to interfere with the functions of the ejaculatory ducts, in fact, in a number of instances the potency has increased as a result of the operation.

CONCLUSIONS.

Studies of the living pathology of chronic prostatism lead us to the conclusion that obstructive prostatic hypertrophy usually involves the two lateral lobes and the median lobe, and that inasmuch as the obstruction is at the neck of the bladder and the obstructing body projects into the bladder, the natural avenue of approach is the transvesical route.

Second, as a result of relieving the distention of the bladder, three phases of kidney secretion are demonstrable; the second phase, lasting from a few days to a number of weeks, constitutes a period of danger during which no surgical attack should be undertaken.

Third, the technic advocated in the present paper includes a two-step transvesical operation in every instance for the relief of benign hypertrophy of the prostate. Preliminary cystostomy is preferred for the reason that, following the suprapubic cystostomy the patient is out of bed in 24 hours; the urinary output from the bladder is completely controlled; there is no unpleasantness or traumatism due to the passage of

the catheter through the urethra, and the operation of transvesical prostatectomy is already half completed.

Fourth, since applying these principles we are able to report to date 28 successive successful cases, every case resulting in the control of urine by the patient and his ability to empty the bladder without using a catheter. In some cases of enormous distention of the bladder, it is necessary to catheterize for a certain length of time before employing suprapubic cystostomy on account of the extreme back pressure on the kidneys, the sudden decompression of which might result fatally.

Fifth, these same rules do not apply in cases where carcinoma of the prostate has been diagnosed, or even where its presence is fairly well suspected. A later communication will deal with this part of the subject.

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THE NORMAL BLADDER AND ITS SPHINCTERS AND THE CHANGES FOLLOWING SUPRAPUBIC PROSTATECTOMY.*

A STUDY BASED ON RADIOGRAPHIC FINDINGS.

BY A. HYMAN, M.D.,

OF NEW YORK CITY,

Adjunct Surgeon to Lebanon Hospital; Chief of Genito-Urinary Clinic, Mt. Sinai Hospital Dispensary.

(From the Genito-Urinary Clinic of Mt. Sinai Hospital Dispensary.)

INCONTINENCE of urine following prostatectomy is encountered infrequently, and very rarely after suprapubic enucleation; it is more often met with after the perineal operation. The cause of this condition has not been definitely determined. The object of this study is to inquire into the mechanism of urination following suprapubic prostatectomy and to note the changes in the topography of the bladder resulting from this operation. It was believed that by such an investigation additional light would be cast upon the question of postoperative incontinence of urine.

As a preliminary it was deemed advisable to make a number of observations of the normal bladder, and of the condition of the bladder in prostatic enlargement, in order the better to correlate the findings.

THE NORMAL BLADDER.

A résumé of the literature dealing with the mechanism of the sphincters of the normal bladder shows that considerable discrepancy of opinion still exists concerning the rôles played by the internal vesical sphincter and the external sphincter, or compressor urethræ muscle.

A brief description of the anatomy of the bladder and its

* Read before the American Urological Association, New York Society, December, 1913.

sphincters may aid in understanding some features to which I shall subsequently refer. Although individual opinions vary, it appears to me that Leedham-Greene [1] presents the best summary of the standard anatomists, and I will therefore quote from his description:

"Anatomists while differing considerably in minor details, describe three more or less distinct constrictor muscles in connection with the bladder and urethra, though their opinions differ greatly as to the part these muscles play in maintaining the closure of the bladder. They are as follows:

"*A.* A slender ill-defined ring of oblique muscular fibres intermingled with elastic tissue, encircles the vesical opening, and is formed of unstriped or involuntary muscular tissue. According as to whether it is regarded as belonging to the bladder proper or to the prostate, it is called the internal vesical 'or internal prostatic' sphincter.

"*B.* Below the internal sphincter some short transverse muscular fibres are present on the anterior or ventral surface of the lower or distal half of the prostate. They rapidly increase in length as they approach the apex of the prostate until they completely encircle the urethra. The majority of these fibres, chiefly composed of voluntary muscular tissue, are situated on the outer surface of the prostate. All these fibres together comprise the external prostatic or vesical sphincter of Henle, which according to Griffiths [2] is merely the commencement of the constrictor urethræ.

"And lastly, surrounding the membranous urethra, contiguous to the anterior portion of the external prostatic sphincter is that muscle, or group of muscles, best known as the compressor urethræ."

It is well recognized, that but two of these muscles are of importance in the act of micturition, the smooth muscle, involuntary internal vesical sphincter, and the striated voluntary compressor urethræ.

Concerning the topography of the normal bladder the following may be said. The most fixed portion of the bladder is the outlet, being firmly held by its attachments to the prostate and urogenital musculature. The position of the sphincter, of

course, varies according to the skeletal development, the musculature, the age of the patient and the condition of the neighboring organs; for it can readily be seen that tumors, congenital defects, prostatic enlargement, and other pathological conditions influence its location. According to Langer,[3] the internal urethral orifice in a normal, slightly-filled bladder is between 2.2 and 4.5 centimetres from the posterior aspect of the symphysis. As the bladder distends the orifice is pushed downward. Richet locates the internal sphincter on a line from the under border of the symphysis to the fourth sacral vertebra; while Kohlrausch[4] places it on a line from the upper border of the symphysis to the tip of the coccyx. All these observations were made upon the cadaver.

The contour of the normal bladder has long been the subject of much discussion. Most of the work in this connection has been carried out upon the cadaver by means of different methods. The bladder has been filled both from the urethra and from the ureters with wax, plaster of Paris, formalin and other solutions; it has been inflated with air, and has also been studied by means of frozen sections. As a result of these investigations the bladder has been variously described as being cylindrical, ovoid, elliptical or spheroid. It is evident, however, that the bladder is not equally distensible, for if it were so, its shape when filled would be round. Furthermore, Langer has carefully demonstrated that the region of the outlet is the least distensible, especially so at the trigone. His observations are borne out by the fact that in the markedly distended bladder there is but slight variation in the distance between the two ureters.

In 1905 a new method of studying the form of the bladder was devised by Völcker and Lichtenberg.[5] They employed collargol injections combined with radiography, and as a result of their work concluded that the normal bladder when distended is invariably broader above than below, and is never round. Subsequently Leedham-Greene, using the same technic, reported that the radiographs he obtained showed the bladder to be oval in shape. His photographs, however, demonstrate a bladder round in form. More recently two articles have

appeared dealing with this subject; in the first, by Barringer and MacKee,[6] the results obtained coincided with those of Völcker and Lichtenberg; in the second, by Uhle and MacKinney,[7] the radiographs more closely resembled the round form of Leedham-Greene.

Turning now to the action of the sphincters when the bladder is fully distended, a study of the literature again discloses considerable difference of opinion; all authors, however, are agreed that in the moderately distended bladder it is the internal vesical sphincter that is active in retaining the urine. This diversity of opinion is due in part to the different methods employed. The earlier investigators worked on the cadaver. Thus Born,[8] using ureteral injections of plaster of Paris, found that the closure took place at the internal vesical sphincter. From a series of anatomical studies Kohlrausch believed that folds of mucous membrane which he found near the internal urethral orifice acted as the sphincter. Barkow[9] termed the internal urethral orifice, the annulus elasticus, and considered that the sphincter. Henle,[10] however, showed that the action of this sphincter was not due to elastic fibres, but to smooth muscle, so that this constituted a true sphincter. Later anatomists and clinicians making their studies on animals and the living human being placed the seat of vesical closure at the external sphincter, the compressor urethræ muscle. Guyon,[11] Ultzman,[12] Finger[13] and many others were of the opinion that in the distended bladder the internal sphincter was not of sufficient strength to retain the urine. They believe that when the bladder is distended the posterior urethra becomes part of it, forming a funnel-shaped outlet, with the closure taking place at the compressor urethræ muscle. These authors base their arguments in part upon the fact that in the fully distended bladder the urethra is from one and one-half to two centimetres shorter than when the bladder is but moderately filled. v. Zeissel,[14] however, believes that this shortening is not sufficient to justify placing the closure at the compressor urthræ, for if this were so there should be at least four centimetres shortening; that is, the length of the prostatic urethra. More

recent writers (Ruggles,[15] Wilson and McGrath [16]) basing their opinions on the older methods of study continue to adhere to the belief that the compressor urethræ muscle is of paramount importance in retaining the urine in the fully distended bladder. Thus to quote one of these authors, Ruggles, " We all know, or ought at least, that the vesical sphincter is a comparatively weak muscle and that the only muscles by the action of which we are enabled to resist a strong desire to urinate is the external sphincter or compressor urethræ, which is a strong voluntary muscle."

The method of Völcker and Lichtenberg—collargol injections combined with radiography—offered the best physiological method of studying this much discussed question, and conclusions reached by its application appear to me to definitely solve this problem. As previously stated, Völcker and Lichtenberg showed that the bladder is broader above, narrowing down at the outlet; they also demonstrated in their collargol radiographs that the internal vesical sphincter is the sphincter that prevents the escape of fluid from the fully distended bladder; and they never observed a funnel-shaped formation. Later investigators (Leedham-Greene, Barringer and MacKee, Uhle and MacKinney) using a similar technic substantiated their findings. Oppenheim and Loew [17] are the only observers who maintain that the closure takes place at the compressor urethræ. Their work, however, was done on monkeys, using bismuth injections; furthermore, their radiographs were rather indistinct in outline and by no means conclusive.

Before proceeding with the details of the work, I wish briefly to state that my observations on the normal bladder are in the main in concordance with the work of Völcker and Lichtenberg.

TECHNIC AND RESULTS OF RADIOGRAPHIC EXAMINATIONS OF THE NORMAL BLADDER.

These radiographic studies were begun two years ago. In the beginning three different positions were tried, the ventrodorsal (patient lying flat on back), the dorsoventral (patient on

FIG. 1.

Normal bladder distended with 180 c.c. of collargol, showing broad upper portion, narrowing at outlet.

FIG. 2.

Normal bladder distended with 225 c.c. of collargol.

FIG. 3.

Normal bladder of same patient as Fig. 2 taken in dorsoventral position; showing but slight variation from preceding one.

FIG. 4.

Normal bladder distended with 420 c.c. of collargol. Approaches round type of bladder. Urethra sharply demarcated.

FIG. 5.

Normal bladder, same patient as Fig. 4 taken with tube in oblique position, and showing how outlet is cut off by this method.

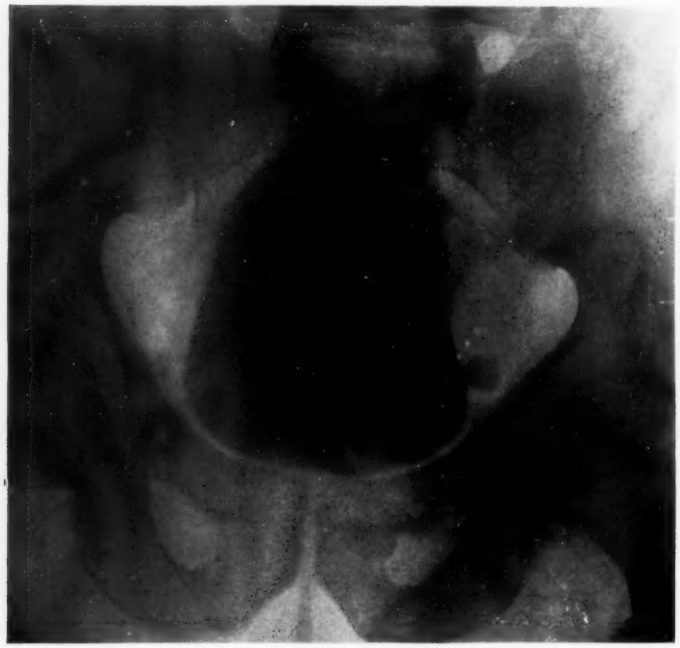
FIG. 6.

Bladder in prostatic hypertrophy; distended with 150 c.c. collargol; showing high location above symphysis with flattening of the base.

FIG. 7.

Bladder in prostatic hypertrophy; distended with 200 c.c. collargol. Numerous irregular shaped diverticulæ present.

FIG. 8.



Bladder in prostatic hypertrophy; distended with 240 c.c. collargol; showing peculiar elongated shape.

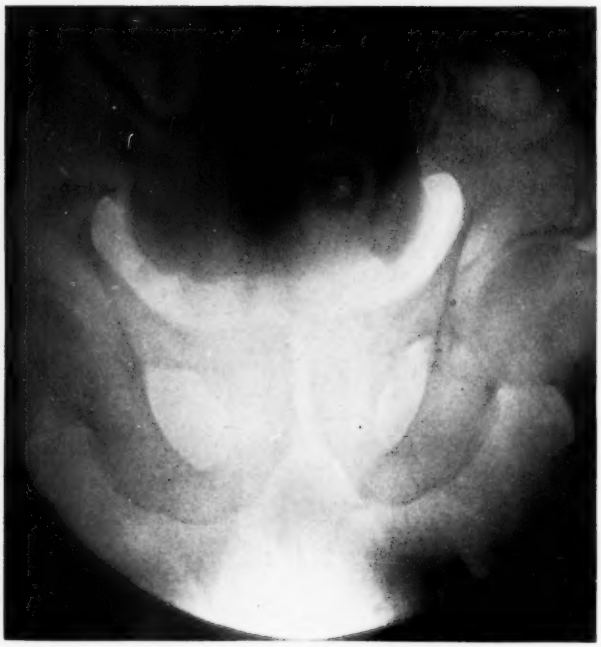
FIG. 9.

Bladder in prostatic hypertrophy; distended with 240 c.c. collargol; showing high location above symphysis, broad, flat base, with urethra sharply demarcated.

FIG. 10.

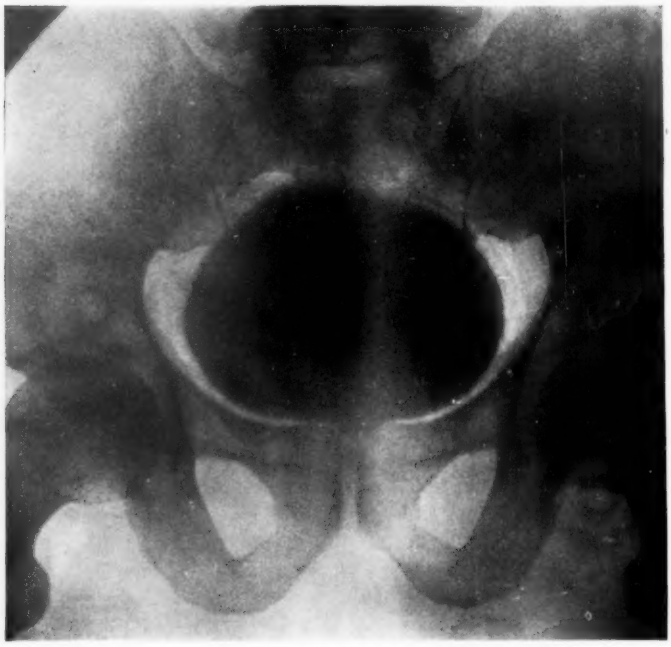
Bladder in prostatic hypertrophy; distended with 180 c.c. collargol; showing irregular shape, high location above symphysis, and two diverticulæ.

FIG. 11.



Bladder in prostatic hypertrophy, distended with 300 c.c. of collargol, showing bulging and irregularity of base.

FIG. 12.

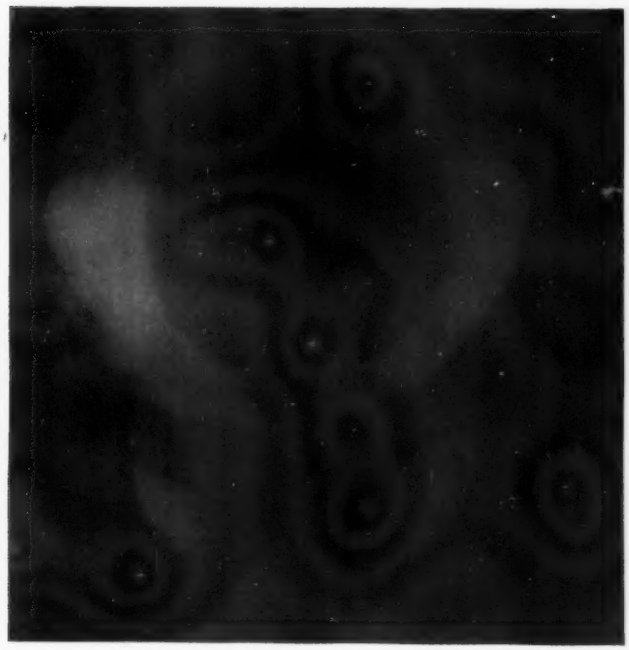


Bladder following suprapubic prostatectomy, 10 months after operation; showing a small funnel-shaped formation.

FIG. 13.

Bladder following suprapubic prostatectomy; 9 months after operation; showing funnel-shaped cavity continuous with bladder.

FIG. 14.



Bladder following suprapubic prostatectomy, 6 months after operation; showing collection of collargol in pouch formerly occupied by prostate.

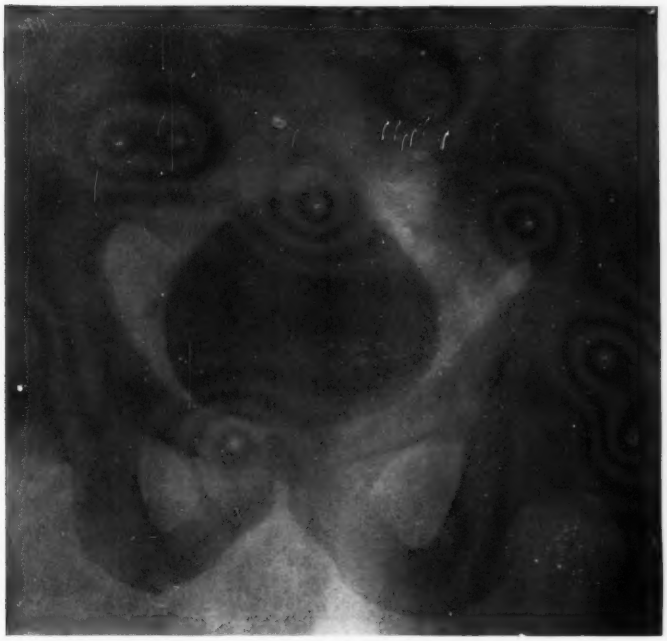
FIG. 15.

Bladder following suprapubic prostatectomy, 1½ years after operation; showing collection of collargol in cavity below and continuous with the bladder.

FIG. 16.

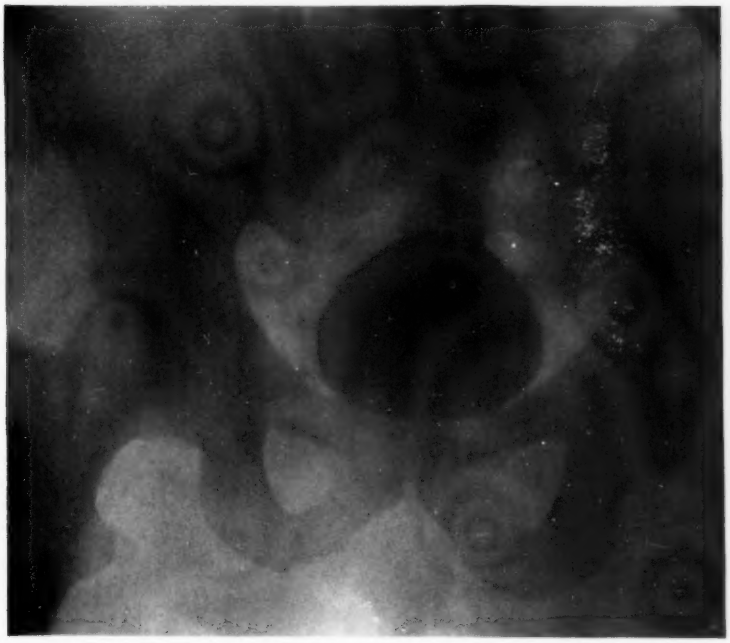
Bladder following suprapubic prostatectomy, 1¼ years after operation; showing collargol in cavity below and continuous with the bladder.

FIG. 17.



Bladder following suprapubic prostatectomy, 1½ years after operation; showing similar condition.

FIG. 18.



Bladder following suprapubic prostatectomy; same patient as Fig. 17 with bladder, however, containing half the amount of solution, and showing similar formation.

FIG. 19.

Bladder following suprapubic prostatectomy, 5 years after operation; showing large collection of collargol in cavity below and continuous with the bladder.

abdomen), and the lateral. The lateral views were very unsatisfactory owing to the density of the muscular and bony structures of the pelvis. The dorsoventral and ventrodorsal gave practically the same results, and the latter, the ventrodorsal position, because more convenient was adopted as a routine. The position of the X-ray tube is of considerable importance. The earlier radiographs were taken with the tube placed posterior and obliquely to a vertical plane passing through the symphysis pubis. It was found, however, that this position failed to give a good view of the outlet of the bladder. Subsequently, therefore, the tube was placed so that its focus was at a right angle to the plate, the rays striking the body just above the symphysis. A compression blend was used; but moderate compression was applied, however, so as not to distort the bladder. The medium used was a 5 per cent. solution of collargol which in the large majority of cases was found to be non-irritating. The solution was introduced through a catheter which was then withdrawn.

Twelve radiographic exposures of normal bladders were made and as the main object was the study of the sphincteric region, the bladders were fully distended.

The shape of the normal bladder was found to be variable, although the type most frequently encountered was that showing a broad upper portion, narrowing down toward the outlet. A few of the pictures closely approached the round type described by Leedham-Greene, while twice the bladder assumed an ovoid shape with the long diameter extending from the fundus to the base. Legueu [18] has recently described a reverse type, the bladder broad below, and narrow above, as characteristic of the normal bladder with the patient in the prone position. This type was not observed in any of the cases in my series. In the radiographs the urethra was invariably found to be sharply demarcated from the bladder, thus demonstrating that the internal vesical sphincter is the muscle that retains fluid in the distended bladder. The position of the internal sphincter was either on a level with the upper border of the symphysis pubis, or midway between the upper and lower borders.

THE BLADDER IN PROSTATIC HYPERTROPHY.

Before beginning a study of the condition of the bladder following prostatectomy, it was considered desirable to take a series of radiographs on unoperated cases of enlarged prostate, in order to better determine the changes following the operation. Marked changes in the contour of the bladder were observed in these unoperated cases. They varied from the small contracted bladder to the larger, irregular, flaccid type. Vesical diverticulæ, so frequently encountered in prostatic enlargement, were distinctly shown in several instances. Changes characteristic of prostatic enlargement are to be found at the base of the bladder. Instead of a broad upper part narrowing at the outlet, the opposite picture was seen. The inferior portion of the bladder was broad and flat or sinuous; at times an upward bulging, due to the gland projecting into the bladder, was observed. This flattening of the inferior portion of the bladder may be said to be characteristic of prostatic enlargement. The bladder was situated on a higher plane than in the normal, the level depending upon the size of the gland. Its base was found to be opposite the upper border of the symphysis, or more often one to two centimetres higher. The prostatic lobes could not be definitely demonstrated radiographically.

The question of sphincteric control in prostatic enlargement seems to me to be decisively settled by the radiographs. Wallace,[19] in a recent publication, writes, "When a prostate enlarges the adenomatous mass sometimes makes its way through and distends the sphincter to such a degree as to render it probably useless. The question of whether the bladder is controlled by the internal or external sphincter remains unsolved. "My radiographs show conclusively, however, that even in the most extreme distention of the bladder the internal vesical sphincter is the seat of closure. When the marked changes in the sphincteric region with the resultant distortion are considered, it is really remarkable that the muscle retains so much of its functional activity.

THE CONDITION OF THE BLADDER FOLLOWING SUPRAPUBIC PROSTATECTOMY.

The mechanism of sphincteric control after prostatectomy is still imperfectly understood. Very few references to this subject are to be found in the literature, and the opinions expressed are not in accordance. Thus Hagner and Fuller [20] in a recent publication state, "that the cause of the loss of control after prostatectomy is a debatable question. It is unquestionably due to the destruction of the muscle at the neck of the bladder, in the prostatic urethra, or in the membranous urethra." Squier [21] is of the opinion that the internal sphincter remains intact and soon contracts to its normal calibre. Other authors, however, have placed the seat of bladder closure following operation at the compressor urethræ muscle. Thus Freyer,[22] reporting an autopsy upon a patient who died twenty-two days after operation, found the bladder pear- or funnel-shaped, instead of globular, the inner surface of the urethra terminating at the triangular ligament. In a personal communication, Lilienthal states that he believes that the compressor urethræ forms the true sphincter of the bladder after prostatectomy.

As far as can be ascertained from a review of the literature but few attempts have been made to study the bladder after prostatectomy by means of radiography. Wallace,[23] using a bismuth suspension, reported one case in which a skiagraph of the bladder was taken. His description is as follows: "The skiagraph shows the bladder cavity continuous with the cavity from which the prostatic adenomata were removed. As the prostate had a distinct intravesical projection the internal sphincter must have stretched considerably. Its situation is presumably at or just distal to the ledge or shelf forming the separation between the two cavities. If this presumption is right, the internal sphincter could not have had any effect in controlling the urine and it must be supposed that a man can have normal micturition without an efficient internal vesical sphincter." Another case, reported by Legueu, confirms Wallace's findings.

Thirty-eight patients upon whom suprapubic prostatectomy had been performed were selected for this study, and in all some seventy-five radiographs were taken. The technic employed was that previously described for the normal bladder. The radiographs were taken at various intervals following operation, ranging from two months to three years. A few of the patients were radiographed several times at successive periods after operation in order to determine if time played a rôle in changing conditions observed. No appreciable differences were noted beyond the fact that an increase in the capacity was evident in the small contracted bladder after appropriate treatment had been instituted.

Concerning the contour of the bladder it was noted that its broad base so characteristic of the unoperated enlarged prostate remained practically unchanged, occasionally, however, the bladder was found on a higher level than in the unoperated case. The vault of the bladder often assumes a pear-shaped form, probably due to adhesions between the bladder and the abdominal wall. The most interesting and important changes are to be found at the outlet of the bladder.

In a small proportion of the cases only a very slight funnel formation in the region of the internal sphincter was observed; in a very few instances no changes at the outlet were to be found. It is therefore evident that in this small group of cases the internal sphincter has not been sufficiently injured by the operation to interfere with its proper function.

In the great majority of the cases (28 in a series of 38 cases) the radiographs showed two distinct cavities, a larger superior one corresponding to the bladder proper, and a smaller inferior one extending from the lower margin of the bladder and continuous with it, to the region of the compressor urethræ. The latter corresponds to the defect left by the removal of the enlarged gland. The contour of this cavity varies from a round or oval to a funnel-shaped formation. The latter is more frequent, the broad base being superior. There can be only one interpretation to these findings—the internal vesical sphincter has either been destroyed by the operation, or its

function so impaired that it could not have had any effect in retaining the fluid in the bladder; this has been accomplished by the compressor urethræ muscle. In other words, the true sphincter of the bladder following suprapubic prostatectomy is situated at the membranous portion of the urethra. That this is so, I have been able to further prove by urethroscopic examinations of the posterior urethra; also by demonstrating that in these cases a catheter passed just beyond the compressor muscle completely empties the distended bladder without voluntary effort on the part of the patient. There can be no question that the compressor urethræ muscle acts as an efficient sphincter, for all of the cases in this series have excellent urinary control. That the collection of collargol found in the pouch formerly occupied by the prostate is not an overflow phenomenon caused by vesical distention is demonstrated by radiographs showing the same formation in the bladder but slightly distended. A careful examination of the radiographs reveals the fact that in some cases the two cavities are separated by a narrow isthmus. This would lead one to believe that in these instances the sphincter has either partially regenerated after the operation, or was incompletely destroyed by the operation. That the cavity left by the enucleation of the gland is not obliterated, and that the internal sphincter is not completely regenerated, is shown by the very definite radiographs after an interval of three years.

In conclusion it may be stated that

1. The internal vesical sphincter is the true sphincter of the normal bladder, and of the bladder in prostatic enlargement.

2. The external vesical sphincter, "compressor urethræ," is the functionating sphincter after suprapubic prostatectomy in the large majority of cases.

I desire to thank Dr. Edwin Beer, Attending Surgeon to the Genito-Urinary Service of Mount Sinai Hospital, for having placed his material at my disposal; and Dr. Jaches and Mr. Scholtz, of the X-ray Department, for the excellent röntgenograms.

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[19] Wallace: Prostatic Enlargement, London, 1907.
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[22] Freyer: Surgical Diseases of the Urinary Organs, London, 1908.
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EVERSION OF BLADDER.

AS A LATE SEQUEL OF MUTILATION CAUSED BY RAPE IN EARLY CHILDHOOD.

BY HORACE PACKARD, M.D., F.A.C.S.,

OF BOSTON, MASS.,

Professor of Surgery, Boston University.

IN a recent hospital service a young woman twenty-one years old presented herself with the following history:

When a child of fours years she was enticed away by a strange man and raped and left unconscious. She was found some hours later and taken to the nearest physician, who succeeded in checking a slow hemorrhage from a ruptured perineum and bladder. She rallied from the immediate effects of the assault and later was taken to the Memorial Hospital in Worcester where she received surgical attention, including two operations on the bladder. She suffered incontinence of urine from the time of the assault. The operations failed to relieve her. In the subsequent years she had constantly leaked urine but with the aid of a portable urinal she had successfully held her own in school life and had graduated at the High School. She had faced her infirmity with surprising patience and fortitude. What now led her to seek hospital aid was a disquieting and embarrassing physical change at the vulva which had slowly developed making it almost impossible for her to sit up or be about. On examination the condition was found which is exhibited in the accompanying color sketch (Fig. 1). There was complete procidentia uteri with also complete eversion of the bladder. There was no meatus and no trace of a sphincter. The bladder mucous membrane was in a chronic state of inflammatory infiltration, intensely red and granular. The ureteral openings were plainly demonstrable. An X-ray study showed absence of the pubic arch (see Fig. 2).

Analysis of the condition as a whole seemed to warrant the following conclusions. At the time of the assault most violent injury was done to the perineum, the anterior vaginal wall, the bladder, and the pubic arch. The pelvic floor was so mutilated that it no longer furnished support for the uterus, therefore, as the patient

developed into womanhood the uterus sank down until it occupied a position entirely outside the body. With the prolapse of the uterus the ruptured bladder had been dragged down and completely everted. This eversion was possibly more extreme and prominent because of loss of the pubic arch. The absence of the pubic arch presented a more difficult problem for solution. On exposure of this condition by the X-ray the question came up as to the possibility of a congenital defect—an exstrophy of the bladder—and an error in the story of assault, rape, etc. All questions on this point were thoroughly banished by the testimony of the physician who attended her immediately after the assault (Dr. R. W. Swan, of Worcester, Mass.) and her own straightforward story of perfectly normal urinary function prior to the assault. It is indeed difficult even at this writing to comprehend such injury to the pubic arch as shown in the skiagraph unless infection, at the time of the assault and subsequent thereto, reached the pubic bones and a destructive osteomyelitis was the real cause of the osseous defect. What could be done surgically to relieve this distressing condition? Obviously the first thought was a plastic operation to cover the bladder defect and afford protection to the exposed mucous membrane, followed by some kind of an operation to remedy the procidentia. Careful consideration of all the attendant conditions seemed to point to the following conclusions:

1. Since there was no urethra, no sphincter vesicæ and no meatus urinarius remaining, any efforts to reconstruct the bladder would only result in the formation of a cloaca, lined with hopelessly diseased and infected mucous membrane which would be, throughout the rest of the patient's life, an unclean pocket and would in no wise serve as a reservoir for the urine.

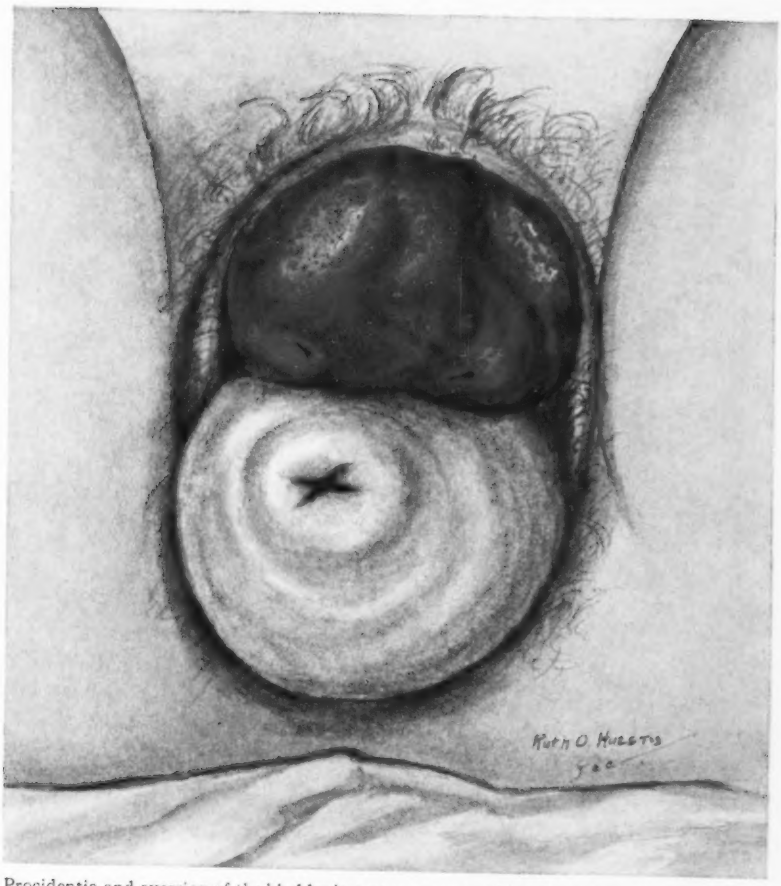
2. Any effort to construct a continent bladder would be doomed to failure.

3. The everted, prolapsed, diseased bladder mucous membrane could not be advantageously utilized in any conceivable operation, therefore why save it?

4. Reduction of the procidentia and ventral fixation of the uterus would permanently relieve the patient from the annoyance of the protruding mass.

5. Removal of what remained of the bladder, transplantation of the ureters to the vaginal wall, closure of the defect left after

FIG. 1.



Procidentia and eversion of the bladder in a young woman of twenty-one years, as an indirect result of a criminal assault when she was four years old.

FIG. 2.

Loss of the pubic arch, apparently as the indirect result of a criminal assault upon a girl four years of age. Skiagraph exhibit seventeen years after.

the bladder was removed and ventral fixation of the uterus was decided upon as most likely to contribute the greatest amount of relief.

This was explained to the patient with the fact that the operation would not stop the leakage of urine, but that it would hereafter emerge by way of the vaginal canal. She eagerly accepted any plan which afforded relief from the wretched condition she was then suffering and added " that the mere leakage of urine, to which she had accustomed herself over a period of seventeen years, would be of such trifling moment in comparison with her present condition that she should consider herself fortunate in securing the relief offered by the proposed operation."

Operation was performed in accordance with the plan above outlined. The whole of the remaining bladder mucous membrane was dissected away. The ureters were transplanted to the vaginal mucous membrane and sutured in place. The defect left by removal of the bladder was closed by deep and superficial sutures. An opening was then made above the pubis and very firm ventral fixation of the uterus effected by entangling the fundus with the recti muscles and fascia.

Prompt and uncomplicated healing followed with entire relief, except the irremediable one of urinary incontinence.

ARTERIOVENOUS ANEURISM OF THE EXTERNAL ILIAC VESSELS, WITH WOUND OF THE EXTERNAL ILIAC VEIN.

BY BERTRAM M. BERNHEIM, M.D.,
OF BALTIMORE, MD.,
AND
PEREGRINE WROTH, JR., M.D.,
OF HAGERSTOWN, MD.

ARTERIOVENOUS aneurisms are not usually seen by surgeons until some months or years after their occurrence, when they come for operation, as a rule, for relief of circulatory disturbances caused by the back-flow of arterial blood through venous channels to the heart. Unable to withstand the constant arterial beating, the right chamber gradually gives way until relief is afforded by proper treatment of the aneurism. Certain local circulatory disturbances are, to be sure, always manifest in the affected extremity, but it is surprising how little real trouble is thus caused—until, perhaps, it becomes aggravated by the heart complication. This is, therefore, the real reason why arteriovenous aneurisms are seen so late in their course—the unfortunates either succumb before medical aid reaches them or, surviving the first shock, they are so slightly disturbed as to render operative interference unnecessary. Occasionally, however, the rule is broken and a case in point, most unusual and instructive, is the following:

On July 27, 1913, a little boy, L. W. G., aged seven, fell while playing with a pair of sharp-pointed scissors; in falling his abdomen was penetrated by the blades of the scissors, the points entering together (there was only one wound) about one inch to the inner side of the right external iliac crest and parallel to it. The boy was picked up by his mother who noticed but little blood coming out of the wound. A few hours later the family physician, Dr. S. H. Gardner, probed the wound, but finding nothing, had the boy kept at rest in bed for further observation.

In the course of the next few days, a small pulsating swelling developed in the right iliac region in the vicinity of the wound, and coincidently the patient showed a slight elevation of tempera-

ture. No complaint was made of the right leg, but the abdominal mass seemed to increase just a little each day and had almost filled the right lower quadrant by the third day when Dr. Wroth was called in for consultation. A careful examination then elicited the fact that there was a visible pulsation over the mass and a definite systolic thrill present in or transmitted through it. Pulsation was barely perceptible in the femoral artery just below Poupart's ligament, but was absent below this point in the femoral, popliteal and dorsalis pedis arteries. The affected leg felt definitely cooler than the other, whose circulation was perfectly normal. There was no diminution of sensation; and motion, as far as it could be tested, was good. The boy was brought in to Washington Hospital, Hagerstown—he lived in the country—for observation and operation if necessary.

By Sunday, August 3, one week after the accident, the swelling had almost imperceptibly increased in size until it entirely filled the right lower quadrant of the abdomen and even seemed to project a little beyond the mid-line. It was so tense that we dared not attempt to elicit fluctuation, although we felt sure of the fluidity of its contents. The thrill, as noted by Dr. Wroth, was still present, and seemed more easily felt than ever. Definitely systolic in character, it could be traced down the femoral artery by means of the stethoscope for about two inches where it was lost, and beyond which point pulsation could not be felt in the vessel. The condition of the leg was as first noted. The temperature was 102° but there was no abdominal distention, no pain, no signs or symptoms of peritonitis—the abdomen was perfectly soft everywhere except in the region of the swelling. In short, it seemed as if the damage was extraperitoneal and, as will be noted later, such was the case.

The tract of the wound was definitely infected and this compelled us to consider the possibility of a localized abscess having developed on top of the iliac vessels and thus giving the transmitted pulsation and thrill, or an abscess in the vicinity of an arteriovenous aneurism of the iliac vessels. After careful consideration, however, the conclusion was reached that we had to do with an arteriovenous aneurism through which a very slight, a very gradual, but a constant leakage was taking place. The boy was quite pale by this time, his pupils were dilated, his pulse was rapid, he was beginning to show signs of loss of blood. The time for operation had arrived.

The patient having been prepared according to the iodine technic, a God-send in cases of this sort, tapes were passed around the femoral vessels just below Poupart's ligament in order to control any back-flow that might occur; the abdomen was opened through a generous mid-line incision and tapes were placed around the aorta and vena cava just above their bifurcation, to control any sudden hemorrhage that might occur from above. Pulsation was as strong in one vessel as in the other, confirming our diagnosis of arteriovenous aneurism.

Before proceeding further, we had Dr. W. D. Campbell, the second assistant, compress with his two thumbs both aorta and vena cava [1] against the underlying vertebra, and ascertained that by this means practically all pulsation in the swelling could be accurately and absolutely controlled as long as the thumbs held out. Therefore, Dr. Campbell having placed his thumbs in as comfortable a position as possible and all pulsation in the tumor having ceased, the peritoneal covering of the hæmatoma was incised at its most prominent point, liberating about a half liter of dark, mostly unclotted, blood which, in spite of aortic and caval compression, welled up in the cavity as fast as it could be sponged out, effectually blocking all attempts to locate visually the site of the injury to the vessels. Packing was temporarily resorted to, after which, by removing part of the gauze and having Dr. Campbell ease up a bit on the aorta till pulsation could be felt, the vessels were definitely located. Ligatures of umbilical tape were passed around both artery and vein and tied, two well above and two well below what was considered the site of the fistula. Suture of the wounds was out of the question owing to the critical condition of the patient who had, by this time, lost considerable blood.

Desiring to close up as quickly as possible and congratulating ourselves upon successfully getting out of an embarrassing situation, all packing was being removed from the aneurismal cavity when to our consternation there was a gush of dark venous blood, coming apparently from the lower end of the cavity. Hurried palpation in the depths revealed a hole in a vessel large enough to accommodate the tip of the ring finger, which, acting as a plug, prevented further hemorrhage. Heavy ligatures were passed both above and below this opening, but before tying them, the vessel was brought up into view when it was seen that the wound was

[1] This seemed less dangerous than twisting or clamping the tapes, which were to be used only in the direst necessity.

a longitudinal slit about two centimetres long in the dorsal wall of the external iliac vein about one inch before it passed under Poupart's ligament. There was no corresponding wound in the artery. The ligatures were tied and the bleeding ceased.

The condition of the patient was now most critical. Pulsation at the wrist could not be obtained and respiration had all but ceased. A hurried transfusion, by means of the two-piece emergency tube [2] devised by one of us, was done from father to son, during the course of which closure of the abdomen was proceeded with. By the time this was completed, the patient was awake and pleading for water. He went off the table in fairly good condition. His convalescence was uninterrupted and, strange to say, at present his right leg is as good in every respect—sensation, temperature, motion, strength—as his left. Curiously, too, pulsation cannot be elicited in the femoral or popliteal arteries, yet there is pulsation in the dorsalis pedis, a strange anomaly of collateral circulation. There can be little doubt but that the interval of one week which elapsed between the time of the accident and the time of operation was of distinct benefit to the establishment of the collateral circulation, which is responsible for the good condition of the limb.

Reverting to the findings at operation, the question of their explanation naturally arises. There were certainly two separate and distinct vascular wounds (1) an arteriovenous fistula between the external iliac artery and vein and (2) a longitudinal rent in the dorsal surface of the vein separate and some distance from the fistula. It is impossible to question our diagnosis of the existence of a fistula because the thrill, the diminished pulsation in the femoral artery and the absence of pulsation in the popliteal and dorsalis pedis arteries can be explained in no other way. Nor can it be doubted that we cured this lesion in view of the fact that, although we were unable to find the actual site owing to the desperate condition of the patient, ligation proximal and distal to what we considered the site—it will be recalled that the circulation was temporarily cut off and no thrill could be felt as a guide—dissipated the cardinal signs of such a lesion, namely, the thrill and the caval pulsation. This point granted and the hole in the vein having admit-

[2] Bernheim, Bertram M.: An Emergency Cannula, *Jour. Am. Med. Assoc.*, April 6, 1912.

tedly no relation to a hole similarly placed in the artery (careful though hurried search was made for this), the question may be asked, "How did these two separate and distinct wounds occur when there was only one point of entry of the implement which caused them?" The answer, in our judgment, is that the scissors were closed when they entered the abdominal cavity, but, when the handle struck the floor, the sudden jar caused the blades to open with the result that, the sweep being about parallel to the vessels, one blade passed between them, cutting a hole of equal size in their approximate surfaces and causing the fistula, while the other, sweeping downward, caused the rent in the upper surface of the vein at some distance from the primary lesion. Most of the arterial blood then, was immediately shunted over to the vein, as is usual in such cases, only to strike a set of valves a short distance beyond the fistula and be hurled back to the heart through the vein. A small volume of blood passed on down the artery to the leg and was distributed in the usual way. It returned through the usual channels until it reached the rent in the vein when it gradually leaked out of the vessel, giving rise to the hæmatoma as noted. That this formed so gradually is due in part to the diminished supply of blood going down to the leg, and in part to the probable formation from time to time of occluding clots. Had relief not been afforded, the boy would undoubtedly have bled to death within his own abdomen.

It would take us too far afield to consider the question of ligation of the external iliac vessels [3] in its relation to gangrene of the leg. Suffice it to say that gangrene does occur following ligation at this point more frequently than at any other along the vessels of the leg.[4] The reason for this awaits explanation. We had every reason to expect gangrene in this case and were amazed that it did not follow.

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PERFORATING GASTRIC AND DUODENAL ULCERS.*

WITH REPORT OF CASES.

BY FRANK MARTIN, M.D.,

OF BALTIMORE, MD.,

Professor of Operative Surgery and Clinical Surgery in the University of Maryland.

I HAVE tabulated the following list of cases for publication because it is a condition, in my opinion, more commonly overlooked in its acute stages than any other surgical malady, and for that reason it seems to me that too much cannot be said on this most important subject, and I therefore have published these cases with these few remarks.

Acute perforation of gastric or duodenal ulcers is by all odds the most serious, and, I might say the most tragic, disaster that can happen in the human body. Usually it is a sudden disaster, coming upon a patient from whom you can generally elicit a history of disturbed and imperfect digestion, with attacks at varied intervals of marked indigestion. This, at best, can be gotten, even if the ordinary typical clinical symptoms of gastric or duodenal ulcer are not elicited. These patients bear their burden, go on from week to week, and all at once, like a thief in the night, and oftentimes, according to my records, without any premonition or warning whatever they are seized with severe upper abdominal pain of a violent character, immediately followed by marked peritoneal shock. I know of no condition where the change from apparent health into a condition of great gravity is more pronounced and more marked than in these acute perforations; no disaster in surgery more imminently perilous; none so seldom recognized early; and, in consequence thereof, followed invariably by a fatal issue unless early surgical intervention is resorted to. Those operated on in the first five hours usually recover. After ten to fifteen hours the majority

* Read before the meeting of the Medical Chirurgical Faculty, April, 1912.

in the past have died. I mention this to show that in these cases we have the patient put more rapidly in a perilous condition than from any other intra-abdominal malady that I know of. The picture of peritoneal shock and rapid and oncoming collapse with a scaphoid abdomen, hard and rigid as a board all over, soon changes and the symptoms of rapid peritonitis are pretty speedily noted.

One of the first notable contributions to the subject of duodenal ulcer and its surgical treatment was the address of the President of the American Surgical Association in 1900, Dr. Robert F. Weir. The total number of cases then reported was small and nearly all of them were acute perforations into the free peritoneal cavity.

In most of the recorded earlier cases a correct diagnosis was not made before operation, and all the symptoms sufficiently urgent to demand immediate operation and the true condition found at operation. In many of the later cases an accurate diagnosis, fortunately, has been made before operation, due to the typical syndrome of symptoms, which, when observed, more and more certainly speak for the occurrence of this serious disaster, and in consequence of early operative interference being resorted to, many lives have been saved.

The condition is most frequently mistaken for acute appendicitis, because the pain a few hours afterward is more commonly referred to the lower abdomen. Also, it is frequently mistaken for acute hemorrhagic pancreatitis. If close attention is given to the history in each case, there will be noted prior to the oncoming of urgent symptoms the history of previous indigestion, extending in most cases over a long period, with attacks of pain in the epigastric region, with regurgitation of acid secretion, not only during the period of digestion with food, but also from a stomach empty of food, at a time when it should be free of acids. These symptoms can be usually gotten in the history before the symptoms of the attack of perforation makes itself manifest, which, when it occurs, is so markedly accompanied by such sudden, severe pain in the epigastric region, followed immediately by pro-

nounced peritoneal shock, with the rapid oncoming of a board-like and scaphoid abdomen, should make the observer in each case when such symptoms are pronounced, turn his attention to the region of the stomach as the cause of them, and think of a gastric or duodenal perforation as being at the bottom of this fulminating, acute, and collapsing condition, which becomes hourly more and more pronounced, until the chances of relief being offered by operation are exceptionally slight. It is certainly the one condition of all others where even a few hours of waiting costs the life of the patient.

In the slow perforations and early in the acute ones the extravasated material passes down the right side of the abdomen over the omentum, or to the outer side of the colon to the right iliac fossa, and here gives rise to tenderness and rigidity, but it is to be borne in mind that in these cases there is also associated acute tenderness and rigidity over the perforation above. The board-like and scaphoid abdomen is always present early, and not until there is a diffuse peritonitis does the abdomen become distended. With such a picture, immediate operation is called for always, and when the stomach history is elicited, as I have above stated, perforation should be suspected after the elimination, as far as possible, of other conditions.

In all of the cases I have come in contact with the pain has usually been in the epigastric region in the early stages, of a sharp, sudden, and agonizing character, and the abdominal rigidity early becomes general and board-like. The scaphoid and rigid abdomen constitutes, in my mind, one of the most marked and valuable signs of perforation, and continues until the peritonitis advances. Then the distention is noted. Distention is never noted in the early stages, and when noted, indicates a degree of peritonitis from which the patient will seldom recover.

Collapse is a variable occurrence. It takes place early, as a rule, and may be profound. Arrest of intestinal peristalsis occurs only after the peritonitis is sufficiently advanced to produce paralysis of the intestines. It is of no special diag-

nostic aid. The absence of liver dulness, associated with a scaphoid and rigid abdomen, is an invaluable sign of perforation. When the distention has come on, the diminution or absence of liver dulness is of little value.

Temperature in the early stages is usually normal, subnormal, or but slightly elevated. Seldom is high temperature noted. Pulse rate is increased, the pulse becoming very weak, thread-like, and rapid if collapse is present. Usually, the respiration is entirely thoracic and shallow, and the respiration rate increased. Leucocytosis is noted early, but more marked as the case advances, going as high in some of my cases as 30,000. I do not lay much stress on the dependency to be put in leucocyte count as an aid in the diagnosis in the early stages of perforation. The previous history of the patient is of great importance, and when associated with the symptoms of agonizing, stabbing pain in the epigastric region, followed by shock and collapse, attended with vomiting, subnormal temperature, rapid, thread-like pulse, accompanied with a board-like scaphoid abdomen, with or without rise of temperature, we have here a complete classic and ominous picture of a perforating peritonitis, of either duodenal or gastric origin.

The symptoms in duodenal ulcer in most cases are perfectly characteristic, and admit of an unhesitating diagnosis. Sometimes they exist without any symptoms until a sudden and perhaps fatal hemorrhage or perforation declares its existence. The pain in a measure differs from that of stomach ulcer. It is produced by the irritation of the open ulcer by the hyperacid gastric juice, and comes on after the stomach digestion is complete. In other words, it is more noted just before meals. (Coming on just before meals it is often called "hunger pain," and the patient usually finds that something taken will relieve the pain. This is explained by the pylorus closing when there is food in the stomach and the hyperacid juice no longer gains access to the duodenum.) It sometimes occurs significantly in the small hours of morning. It is of a burning character, and located in the right midline, or along the costal border. This colicky pain is caused by pyloric spasm.

These patients often do not restrict their food to any great extent, and there is no appreciable loss of weight in the early stages. As the ulcer continues, however, the pain becomes more constant, the diet is often cut down, the patients are underfed, and emaciation results.

Treatment.—From my limited experience I am convinced that success or failure in the treatment of perforating gastric or duodenal ulcer depends almost entirely on the time which elapses between the perforation and the operative repair.

Gibbon and Stewart report a series of twenty-two cases of perforation, and out of the twenty-two there had been ten deaths. In thirteen cases operated on within seven hours, all but one recovered, while the remaining nine, all operated on after twenty-four hours, died. These figures are striking and significant, and other operators' statistics are in accordance. This experience has been noted in my series of cases, and although one case (Case I), was not operated on for three days following the onset of his perforation, he still recovered. It is perfectly possible that an occasional case will be saved, although operated upon late. Still, the point is that usually one chance of saving life is early and complete operation. This I wish to emphasize. The importance of operating as soon as the early symptoms already enumerated have been noted. If distention is waited for, what does it mean? Late peritonitis, with very slim chances of saving life.

Since this condition is so commonly mistaken for appendicitis, the primary incision is oftentimes made in the lower abdomen, and when one recognizes the character of the fluid, a rapid elimination of the appendix and the pelvic organs should be made, and a wet gauze tuck of salt solution should be placed down in the pelvis and left for a temporary drain. The upper abdomen should be at once opened by a second incision. (I consider it very unwise to extend the incision from the lower to the upper abdomen, but make the second incision always, because of the lesser damage to the abdominal wall. Of course, the first incision is not closed, but left to drain while the work is being attended to in the upper abdomen.)

When the peritoneum is opened, one is usually directed immediately to the seat of the perforation by the exudate, which is, as a rule, found in the immediate neighborhood of the perforation. The method of closure must vary with the character of the ulcer, and especially with the degree of induration to the perforation. I usually close it by a mattress suture of fine silk. If the ulcer, whether gastric or duodenal, is very close to the pyloric orifice, care should be observed not to close the pylorus too tightly. I have not yet found it necessary in any of my cases to resort to a gastro-enterostomy.

Mayo reports twenty-seven patients operated upon for acute perforation. "In five, primary gastrojejunostomy was also done, with two deaths. In twenty-two, closure of the perforation alone was made, with abdominal drainage, and but one of the eighteen who recovered required a secondary gastrojejunostomy, the perforation having seemingly put an end to the disease." He believes that an excavating ulcer does not become cured unless excised, or unless nature cures it by a perforation, so that it has been found seldom necessary to do a gastro-enterostomy if the perforation can be satisfactorily closed. Where it has been satisfactorily closed, the next step in the operation is to institute proper toilet of the peritoneum, and proper drainage. As to the question of irrigation which at once arises, I personally do not make use of it. I believe that well-placed suprapubic tube drainage, with gauze protected by rubber tissue, is all that is necessary.

Suture of the perforation with pelvic drainage with the patient being subsequently placed in the exaggerated Fowler position gives the best results. The mooted question concerning whether or not a gastrojejunostomy shall be done at the same time usually is not necessary if the perforation lies, as I have just said, near the duodenum or in the pylorus, it should be sutured transversely to avoid a stricture of the lumen occurring at this point.

My chief objection to doing a gastro-enterostomy in the height of a peritonitis of this kind is the additional shock added to the patient, and from the fact that it is not usually

found necessary. What is necessary is more or less prompt speedy operation, without adding undue shock to a condition which is already most precarious. The justification for this gastrojejunostomy in the majority of the cases is very questionable, and only a few cases are reported where the subsequent gastro-enterostomy has been called for. The later treatment of these cases varies a little from the ordinary case of peritonitis. The Fowler position, continuous normal salt by rectum by the drip method or the Murphy method are immediately begun, and in this way large quantities of salt solution are immediately taken up. Nothing is given by mouth for a certain number of hours, relying on the fluids taken by rectum. The question of posture is one on which the surgeons differ. I, for one, believe much good comes from the Fowler position.

The cases are presented chronologically.

BRIEF SUMMARY OF CASES.

CASE I.—Man aged thirty-eight. Entered with diagnosis of peritonitis; cause, perforating duodenal ulcer; lower abdomen opened and drained; result, died. Autopsy showed the perforation to be duodenal.

History.—He was brought to my service at St. Joseph's Hospital during my absence from town. He had a well advanced peritonitis, and was operated on by another operator, on account of my absence, and a lower abdominal incision only made use of. They found free pus in the abdomen and looked for the appendix and found it not at fault, and the man's condition was such that they only instituted pelvic drainage and did not open the upper abdomen for further inspection. He lived for eight or ten days, and died. An autopsy was gotten, and showed the cause of the peritonitis to be a perforating duodenal ulcer. The perforation was still open and leaking, and was located in the first portion of the duodenum. This was the first case that ever came in my service. It was some years ago, very little was known about the perforating ulcer being the cause of peritonitis, and I presume that this explains why the upper abdomen was not opened.

CASE II.—Man aged fifty; came into hospital May 7, 1907;

operation declined and he died the next morning. Autopsy showed a general peritonitis, caused by a perforating duodenal ulcer.

History.—In my service at St. Joseph's, May 7, 1907; man aged fifty. He was taken acutely ill with severe upper abdominal pain and vomiting on the fifth, two days prior to coming in. This persisted, and he entered the hospital on the night of the seventh. I saw him at eight o'clock, one hour after his entrance. He then had a tense, rigid abdomen; leucocyte count 13,000; pulse wiry, small and extremely bad; hand and fingers cold, and his condition was most unpromising. I offered operation; it was declined. He grew rapidly worse and died on the morning of the 8th. The belief was, and the diagnosis was so advanced, that he had a perforating gastric ulcer. He had been a hard drinking man and gave suspicious history of gastric ulcer in that he had previous attacks of vomiting, the vomitus containing blood, with upper abdominal pain.

NOTE (May 11).—An autopsy was gotten and a general peritonitis revealed, the cause of which was a perforating duodenal ulcer. The ulcer was just distal to the pyloric orifice and the peritonitis was rather advanced, having existed since the night of May 5. From the time of the perforation to the time I saw him was forty-eight hours. His condition, as I above stated, was that of a man profoundly shocked, practically in extremis. Operation was declined, and he died the following morning.

CASE III.—Mrs. L. L., aged forty-five; residing in this City; operated on June 30, 1908; perforating duodenal ulcer; operation thirty-two hours after onset; recovery (Martin).

History.—I was called about six o'clock on the evening of June 30, 1908, by Dr. J. G. Wiltshire. The patient's previous history showed that she had been a delicate woman and had been in the hands of many doctors; had been treated for many years for retroverted uterus; five years ago she was operated upon by a leading gynæcologist for a ventral fixation. She had been more or less of an invalid ever since, not altogether laid up, but having various and sundry complaints. There was no definite stomach history, no vomiting of blood, no occult blood in the stool, no special symptoms of gastric discomfort given in the history. On June 29, thirty-one hours prior to my seeing her, she was seized with acute abdominal pain and vomiting. This

persisted all the afternoon and night of the 29th, up until the morning of the 30th. Various and sundry efforts were made to move bowels without success; numerous medicines; numbers of enemas, and even croton oil, were given. I saw her about six-thirty on the 30th; mouth temperature 100°. The picture presented was that of general peritonitis; limbs were drawn up; abdomen tense, tight, and very much distended; principal pain on palpation was over the appendix region. I expressed the opinion that she had a general peritonitis from some cause, and advised immediate operation.

Operation.—She was sent at once to the Union Protestant Infirmary, and preparations were made for immediate operation. Under ether the abdomen was opened through the right rectus. As soon as the peritoneum was opened thin pus welled out from every direction. It was then noted that this pus was also markedly bile stained. I immediately sought for the appendix and found it almost entirely obliterated except about a quarter of an inch of cæcal end; no inflammation. This was eliminated as a cause. Pelvis was explored, no trouble there to account for peritonitis, nor was there any evidence of a ventral fixation having been done. Both ovaries had been removed. A gauze pack wrung out in salt solution was put in the pelvis and left. I then proceeded to open the upper abdomen, making the usual incision through the right rectus. A quantity of exudate was noted as soon as the peritoneum was opened, which extended up in the gall-bladder region and under the liver. The pylorus was seen, but nothing found to be wrong in that region; a certain amount of exudate all around the sub-hepatic area and about gall-bladder. Gall-bladder was tense, but no perforation could be seen in it. In lifting liver and pulling it out with the retractors and pushing stomach over, an opening was found in the duodenum, looking at first as though it were in the common duct. The tissues all about were necrotic, as likewise was the pancreatic tissue covered with necrotic exudate. In getting away the exudate and opening up the parts, the opening was seen, as I above said, in the duodenum, in and about the region of the common duct. Bile poured out from this opening very freely, and it was thought that the opening was in the common duct pure and simple. In fact, a small common duct stone came out with the outpour of bile. The gall-bladder was somewhat distended with

bile, and a stone felt in it. It was opened, the stone removed, and a tube introduced for drainage. Impossible to get at this opening in the duodenum to close it; a drain was left at that point, also one in the gall-bladder, iodoform rubber tissue tucks placed down into the sub-hepatic space, and the opening in the duodenum and the wound closed up around these drains. Bile poured out very freely. Then a tube was placed into the pelvis through the lower opening, several rubber tissue tucks placed around it, and the wound closed up around the drain tracts; cat-gut used, except for the skin; *no irrigation of the abdomen made use of*. She was considerably shocked when she went off the table and intracellular salt was given, 1000 c.c. She was put in the Fowler position and the Murphy salt drip method by rectum was instituted.

Post-operative History.—The patient's convalescence was uneventful. For a number of days there was a great outpour of bile from the drains in the upper incision, but the wounds ultimately closed and the patient made a nice convalescence. In the summer of July, 1911, she returned to the Union Protestant for the closure of a ventral hernia, which occurred at the drain tract in the lower incision. This was closed and a good recovery made. The patient is still living and in good health at the present date.

CASE IV.—Mr. J. P., aged fifty years; University Hospital; perforating duodenal ulcer; drainage through three incisions; operation December 2, 1908, two weeks following the first symptoms of the perforation; result, cured.

History.—Patient fairly well-developed white man, fifty years of age; had been under the care of Dr. Slade, his physician, for two weeks with the history that the initial symptoms were pain, which came on suddenly in the upper abdominal region, which continued spreading to the right hepatic region and off into the right side. He suffered great pain, and had what he called "tremendous sweats," principally at night, when his clothing would be soaked. He had fever continuously, and marked tenderness in the upper abdomen. I saw him in consultation out in the country the night of the 26th and advised him to be brought into hospital immediately for operation. He had then symptoms of general peritonitis. The diagnosis was thought to be appendicitis. In palpating his abdomen I was convinced

that he had definite suppuration in the upper abdomen as well as the lower abdomen, and expressed the opinion that I did not think appendicitis was the cause, but more than likely that it was due to a perforating gastric or duodenal ulcer. The abdomen was markedly distended and tender universally on pressure, particularly in the right side and above the umbilicus. He was not entered into the University Hospital until mid-day of December 1. When I saw him he presented such a haggard facial expression and was so completely "all in," as it were, that I thought it unsafe to attempt any operative procedure that day, as I did not believe he would live through it. His rectal temperature was 104°; leucocyte count 33,000; pulse 130. He was put in the upright sitting posture and salt solution given both intracellularly and by rectum. The following day, December 2, I decided to operate. He was practically no better. His leucocyte count was 35,000; pulse very quick and of no volume; rectal temperature subnormal; he looked badly, had a bluish, cyanotic tinge of skin, and presented a picture of rapid going down from abdominal suppuration.

Operation.—This was performed in the early morning of December 2. The abdomen was opened by an incision in the lower abdomen, a quantity of pus and yellowish fluid escaped, with some gas. The whole abdomen was in an advanced stage of general peritonitis, pelvis full of pus, and lots of exudate between layers of coils of intestines. On passing a hand down into the pelvis a lot of white, flaky pus welled out. Around the cæcum there was a lot of fresh exudate and a regular layer of exudate one-sixteenth of an inch thick. The appendix was covered over with this exudate. It was rapidly taken off, but there was no evidence of perforation in it, and it was eliminated as the cause of the peritonitis. A large gauze tuck wrung out in salt solution was placed in the pelvis and a second incision was made in the upper abdomen through the right rectus and as soon as the peritoneum was opened a huge abscess was gotten into, consisting of the same flaky pus. A quantity of exudate was all around in this region, around the liver and stomach and duodenum. There was no perforation in gall-bladder, but the exudate extended to the under surface of the liver and around the gall-bladder, and in this region a great quantity of pus welled up from the back. In separating the duodenum

from the exudate holding it to the under surface of the liver, a large necrotic area was seen to extend into the liver and back toward the back. The exudate was wiped away and the perforation was seen in this area of duodenum, welling up under the liver. The man's condition was so wretched that I did not stop to suture this opening, but made a third opening in the ileocostal space in order to drain this large abscess into the subhepatic space, running down to the right side. The infection seemed to have extended into the liver, and practically giving him an abscess likewise in that region. At any rate the suppuration was so extensive and the exudate so great it was hard to say whether the abscess had extended into the liver proper or not. A large drainage tube was put from the back into this necrotic area of the liver, with iodoform tucks around it. Rubber tube drainage was also put into the upper incision, connecting with the tubes that ran in from the ileocostal space and down to the region of perforation. His condition was so extremely grave he was given salt solution while the operation was going on, and oxygen also was administered. After getting the drainage placed in the upper abdominal incision and the incision through the ileocostal space up under the liver, a tube was placed through the lower opening in the pelvis and the wounds closed around the drains. He went off the table in a condition of profound shock, and there was very little hope felt for his recovery. The suppuration was so wide-spread that it did not seem possible that he would come out of it.

Post-operative History.—It was noted he showed evidence of recovery from the shock and sepsis, and drained very, very freely through the numerous drain tracts. There was a considerable amount of bile from the posterior tract; the temperature and pulse showed a tendency to approach the normal line, and after a very stormy convalescence, and replacing of drains of smaller size, the wounds ultimately closed, and but for a setback which occurred on December 18, he steadily improved. It was noted on December 18 that he complained of a sharp pain in the left side of his chest over the seventh and eighth ribs. Auscultation over this area revealed a definite friction rub. With proper treatment instituted about three days later the pain subsided and friction rub disappeared. For about five days the patient ran a normal temperature and pulse and was getting on nicely. Two

days later he ate a piece of cocoanut cake without permission, which was followed by intense abdominal pain, chill, temperature reached 103°, pulse 140, clammy skin, and profuse perspiration. The stomach was washed out, bowels moved freely, and he got some relief. His temperature and pulse ran irregularly for about a week and then came down to normal. I attribute most of these setbacks and sudden rises in his temperature and quickening of his pulse as due to recurring leakages that took place from the still unhealed perforation. About a month following the operation the drainage tubes were all removed and the tracts granulated up. About six weeks after the operation he left the hospital *cured*. This patient was one of the illest patients I have ever seen get well.

CASE V.—L. S., aged twenty; operated on at St. Joseph's Hospital for perforating duodenal ulcer June 22, 1909, twenty-three hours after the perforation; result, died.

History.—This man was taken sick with violent abdominal pain on June 21, twenty-three hours prior to my seeing him, with what was supposed to be lead colic. He was seen by me late in the afternoon of June 22, when it was seen that he had general peritonitis, and his condition was rapidly growing worse every hour. Immediate operation was advised. He had a very feeble, wiry pulse, dry tongue, facial expression of a man rapidly dying from some poisoning. He was operated on shortly after his coming in, so there was no careful previous history obtained in his case. He was supposedly well, when he had this onset of severe, upper abdominal pain, which grew steadily worse in intensity and continued on with marked and progressive symptoms of collapse, showing themselves the day of his entrance. He had, when I saw him, evidence of general peritonitis; tense, tight abdomen, and beginning distention, so he was taken at once to the operating room.

Operation.—Lower abdomen opened; the peritoneum and cellular tissue just under muscle and between muscle and peritoneum were filled with jelly-like exudate, and as soon as the peritoneum was opened a quantity of yellowish, straw-colored fluid welled out. Fresh exudate was seen all over the intestines; in other words, there was a diffuse general peritonitis. This seropurulent fluid welled out in great quantities from all sections of the abdomen. It was likewise bile tinged. The appendix was

sought for and seemed to be normal, covered with exudate, as likewise were the intestines all about. A hand was passed into the pelvis and a quart or more of this fluid welled out. A good deal was mopped out and then a gauze pack wrung out in normal salt solution placed in the pelvis for drainage. The second opening was made in the upper abdomen through the right rectus, toward the midline, and before the peritoneum was opened this same jelly-like condition in the tissues prior to reaching the peritoneum, as was noted in the lower abdomen, was also noted here. When the peritoneum was opened a great quantity of seropurulent fluid welled out in great abundance, with free exudate all over the stomach and omentum and adjacent structures. As the stomach was pulled toward the left side I saw a perforation in the duodenum. It was punched out like a bullet hole, about the size of a little finger, situated about one and a half inches below the pyloric orifice, and this quantity of fluid was pouring out. His condition was that of profound shock, with scarcely perceptible pulse. He was taking the anæsthetic badly, and became rapidly more shocked. The perforation was sewed up with several mattress sutures, which closed it completely, and a Lembert suture put in over this. No irrigation was used in the peritoneum. Drains were then placed and the abdomen closed up around the drain tracts, both in the upper and lower abdomen. The patient did not respond to any quantity of salt solution that was given him, but rapidly sank into more profound shock, and died from the peritonitis some ten hours following the operation.

CASE VI.—Mrs. M. E., Amboy, W. Va., aged forty-three years; University Hospital; gastric ulcer, anterior wall; complicated with cholelithiasis and pericholecystitis; operation October 21, 1909. Result, cured. The ulcer had perforated, but was sealed off in the exudate forming adhesions around it. The perforation was opened up at the time of operation, showing a well-defined gastric ulcer. Part of the ulcer was dissected away and the opening closed. This case is of interest as occurring combinedly with gall-stone disease, having possibly at some time perforated, but was blocked and closed by exudate thrown out by an inflammation occurring about and around the point of perforation.

History.—A brief history of the case is as follows:

She was referred by Dr. James R. Cole. Eighteen years ago she had an attack of trouble with pain referable to the gall-bladder region, and off and on since then she has had attacks

of pain in upper abdomen, etc. Last summer she had jaundice which lasted three months. She said she thought she had had no indigestion except when she had these attacks when there was a certain amount of gas distention; had lost some weight. I advised operation.

Operation.—Under ether I made my usual incision in upper abdomen to right of midline and came down to the edge of the liver and found a mass at the border of the liver, adherent to free border of liver, and pyloric end of stomach was intimately tied up in this mass, and the pyloric arm of the stomach was adherent to gall-bladder, and was tightly tied down by old adhesions. In packing off the subhepatic space and getting the liver up, the free border of the liver showed a cicatrix and this mass was adherent all along free border. In beginning dissection to free adhesions, I first tried to free stomach and in doing so the stomach wall gave way and some contents of the stomach came out. After getting it freed, I found the cause of this giving way was an ulcer which had become adherent to the free border of the liver and fundus of gall-bladder; after getting it freed, I sutured up this opening in stomach, inverted quite a little section so as to turn in opening, and closed it. This was about one and one-half or two inches probably from the pyloric orifice in the pyloric arm of the stomach, on the anterior wall of the stomach down toward the greater curvature. I wish to emphasize right here that this giving way was due to an old ulcer of the stomach, which had caused the dense adhesions to the gall-bladder. I then went on with the operation and did my usual cholecystectomy. She stood the operation well.

Post-operative History.—She made an uninterrupted recovery, and the last report was that she was thoroughly and entirely well, and had no disturbances whatever.

Case VII.—Mr. O. F., aged forty-four years; St. Joseph's Hospital; operation March 6, 1911, three or four days following the first symptoms. Result, died. This was a gastric ulcer with acute perforating peritonitis. He came in practically in a hopeless condition. Diagnosis was made briefly before the operation, and operative procedure was resorted to, but the operation was too long delayed and the patient was too badly poisoned and shocked to recover, and died some hours afterward. He was referred by Dr. Duncan.

History.—He was brought into St. Joseph's Hospital in a

practically dying condition, with diagnosis of appendicitis. When I saw Dr. Duncan he told me he thought the man had gone down unusually fast. When I saw the man I found him practically pulseless and looked him over and in view of the history gotten, the rapid going down of the patient, with the early symptoms being located in the upper abdomen, I expressed the opinion that the man did not have appendicitis, but a perforated stomach ulcer and that I thought the chances of doing him any good very slim, because the perforation had gone too far and his condition of collapse was too great. I advised operation, however, and operated about seven o'clock that night. The history given me is as follows. He had been complaining of pain in the stomach and vomiting for three or four days and had been using a mustard plaster immediately over stomach, and this pain continued until he had *bad pain,* and Sunday afternoon, March 5, he was seen by Dr. Duncan and things were given for relief of pain, and the doctor, thinking it was probably appendicitis, decided not to act and waited until the next day, when he found the patient desperately ill; he had gone all to pieces. He did not bring him into the hospital until late that afternoon, and I saw him shortly after his arrival. I could make out no marked rigidity about appendix region, and with this history of long-standing trouble in upper abdomen I gave my diagnosis immediately as perforated stomach ulcer. I opened him through right rectus and found the abdomen full of a great pour-out of stuff from upper abdomen, and marked peritonitis. I ran my hand down into the pelvis, and pus just welled out from pelvis by the pints—just gushed out; gauze packing was put down in pelvis and then I opened upper abdomen and there was also evidence of peritonitis, and on pulling stomach forward I broke up adhesions that were around the pylorus and as I rolled out pylorus there was a huge hole in pyloric arm of stomach which was so callous and hard it presented the appearance of carcinoma. I take it that it was an old stomach ulcer which had been shut in, and these adhesions had given way and peritonitis had been the result. His peritoneum was overwhelmed with stomach contents, etc., and an advanced peritonitis existed all through the abdomen. He was practically dying; I closed the hole as best I could with mattress sutures and left in drain above and below. He was infused and sent back to the ward, and after a while he seemed

to pick up and improve, but his pulse lagged and after a certain time he commenced to go down and died the following day.

CASE VIII.—Mr. W. S., aged thirty years; St. Joseph's Hospital; stomach ulcer; operation July 6, 1911, at least twenty-four hours after first symptoms of perforation. I saw him in the Dispensary at St. Joseph's Hospital. He had a board-like abdomen, and evidence of distinct peritonitis, with great pain in the epigastric region, and in fact it had extended into the lower abdomen likewise. The perforation existed twenty-four hours before; according to the history it occurred acutely and suddenly, with severe onset of symptoms. Result, died.

History.—Has had diseases incident to children; had pneumonia at age of seven years; has not had typhoid; has had influenza a number of times; has also been troubled with indigestion for fully five years past, and at times would become nauseated and vomit. Two days before his present condition came on he was riding along on the car and became sick; even before he got home he began to have sharp pains in his epigastrium. Habits are good; never drank to excess, but takes a drink occasionally; negative to venereal disease. He entered the hospital on July 5, 1911, complaining of intense pains in his abdomen with nausea and vomiting. The day before, July 4, he was taken with these pains, which recurred both in frequency and intensity until he came into the hospital. His facial expression was that of intense pain. Upon palpating his abdomen pain, tenderness, and muscular spasm were marked. Bowels were constipated, appetite lost, urine scanty, high colored with no cysts or albumen. Slight cough, with little expectoration, no spitting of blood. No swelling of his feet. Patient was operated upon July 6, and there was found a perforated stomach ulcer with a consequent general peritonitis.

Operation.—He was operated on certainly twenty-four hours afterward, and this stomach ulcer was found, and a diffuse peritonitis existing. He was treated by an opening in the lower abdomen, and things excluded there, and found to be in the upper abdomen. As I had previously stated, I thought it was a gastric perforation, still I opened in the lower abdomen to exclude any possibility of a perforated appendix as a cause of peritonitis. Then I opened the upper abdomen and found the perforation in the stomach with a great deal of leakage occurring.

The perforation was closed, drainage instituted both in the lower and upper abdomen.

Post-operative History.—For the first few days he bid fair to do well, up to forty-eight hours, and then his peritonitis flared up again and that continued to grow worse, causing his death, three days after operation.

CASE IX.—Mr. B., aged sixty-six years; Hebrew Hospital; acute perforating duodenal ulcer; consultation May 18, 1911. Result, died.

History.—I saw him in consultation with Dr. Bagley, May 18, 1911, for acute inflammation of the abdomen, which had existed since the 16th. The whole history was that of a stomach or duodenal perforation with sudden onset and violent epigastric pain, rapid oncoming of shock, and a board-like abdomen existing at the beginning of the attack, followed by a distended abdomen, and when I saw him he was in a condition of full-blown peritonitis, with distention and pain, vomiting, no movements of the bowels, and there was some question as to whether he had an obstruction or whether it was an acute inflammatory condition. The whole history was one pointing definitely to a perforation of a duodenal or gastric ulcer, and I so expressed my opinion that I thought it was one or the other, and that the case was most unpromising; in fact, that the perforation, or whatever the cause of the trouble was, had existed since the 16th, and operative interference seemed unpromising. It was advocated, however, hoping it might be of some avail.

Operation.—He was taken into the Hebrew Hospital and operated on by Dr. Bagley. The findings at operation disclosed a perforating duodenal ulcer, and death resulted. This was a hopeless case from the fact that the time existing between the operation and the occurrence of the perforation was over forty-eight hours, and the perforation was so far advanced that death was practically inevitable.

CASE X.—Mr. X., aged forty-nine years; St. Joseph's Hospital; operation April, 1911; result, cured. Duodenal ulcer perforating into the drain tract following an operation done for the drainage of his gall-bladder, or cholecystitis.

History.—He entered St. Joseph's Hospital during January, 1912, with symptoms of intestinal obstruction; was turned over to me with a case possibly of obstruction; considerable vomiting,

and on opening the abdomen I made my incision in the upper abdomen because it simulated possible gall-stone trouble, and as I had seen several cases where the symptoms were similar; namely, those of apparent obstruction due to some infection about the gall-bladder, I made my incision over the gall-bladder region. In going over the intestines I found no definite evidences of obstruction, intestines were ballooned, but there was no trouble there. I found a cholecystitis, and did a cholecystotomy. The patient had rather a stormy convalescence. The drainage in his gall-bladder was left in, I take it, unnecessarily long, and finally closed. Some infection of his wound took place, and it gaped in the upper portion. The wound closed finally, and he went out. After some weeks he returned to the hospital with a discharging sinus at the old drain tract, and it was rather a foul smelling discharge, and apparently it was coming either from the stomach or duodenum. This discharge grew less after treatment and quiet, and gradually closed. Just what happened I was unable to say, except I thought possibly an ulcer of the stomach may have perforated into the drain tract, and so waited on him.

Operation.—In the middle of April his wound was about closed, and I opened down with a view of closing this ventral hernia, which was of a fair size. In dissecting up the adhesions I found an evidence of an old duodenal ulcer, which explained the above mentioned condition. This was such that I could turn it in. The infiltration was not extensive, so I made use of that procedure as a means of correcting the trouble rather than doing a resection. I turned it in, sutured the serous surfaces well over it, and closed his ventral hernia. He made an uninterrupted recovery.

Case XI.—Mr. J. K., British seaman, aged thirty-eight years; University Hospital; perforating gastric ulcer; operation May 3, 1912; admitted to hospital April 8, 1912; complained of pain and discomfort in stomach for a year prior to operation.

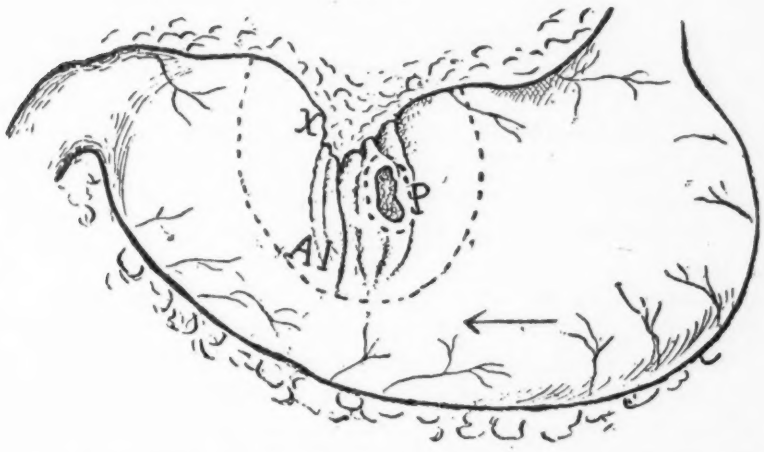
History.—The brief statement that I heard in regard to him was that he was under care in hospital for stomach ulcer. On the morning of the third of May, my assistant informed me that there was a case they thought was perforated gastric ulcer. It had just been turned over to us about fifteen minutes before. The patient was in hospital in the medical services and on the night of the second of May he had bad upper abdominal pain

and a rise of temperature, the chart showing that it had been running normal, and a rapid coming on of marked collapse, with, I presume, a stiffening of the abdomen. The patient grew rapidly worse, but my assistant's attention was not called to him until just prior to my entering the hospital, which was about ten o'clock. I saw him at once, and felt his pulse, which was very shocked, very wiry, and very rapid, and saw the facial expression of collapse and a distended abdomen. I did not stop to investigate further, but ordered him into the operating room, gave my opinion that with his history and the symptoms present, he had unquestionably duodenal or stomach ulcer perforation. He was taken at once to the operating room with a diagnosis made. His condition was bad. It had been a number of hours since this had happened, about fifteen or sixteen.

Operation.—I opened first his lower abdomen and a great quantity of gas bubbled out, and a great quantity of dirty looking and purulent material. I passed my hand down into the pelvis and this creamy looking substance came out of him in great abundance, a quart or more rolled out. I then did not stop to investigate the organs in the lower abdomen, but with this escape of gas and this great quantity of fluid and matter, I put a large salt tuck into his abdomen to let a certain amount of this be absorbed, and then immediately opened his upper abdomen. As soon as the peritoneum was opened gas escaped from there and a quantity of this same material was noted, and a lot of exudate was seen filling the upper abdomen. The material seemed to be welling out from an opening somewhere in the region of the stomach or duodenum, and, as I expected, the adhesions grew more and more as I worked my way up under the liver. The tissues there were covered with a dense layer of exudate, the material seemed to drain out all the way down. Under the liver there was a great quantity of exudate, and as I pulled the stomach forward I thought at first I saw the perforation in and about the neighborhood of the pylorus, but on getting things better opened up and tucked off, I found this to be a mistake, but that the perforation was right to the cardiac side of a big saddle ulcer, which extended down from the lesser curvature toward the greater curvature on both the anterior and posterior walls of the stomach, more or less fixing the stomach because of the dense infiltration extending out from this saddle-like ulcer

into the surrounding tissues. It was held down in this position out to this marked infiltration and induration. This had produced a regular hour-glass contraction of the stomach (Fig. 1). All within the dotted line shows dense infiltration into the ulcer-bearing area to the greater curvature, leaving only a small way out for the cardiac pocket of stomach to the pyloric pocket of stomach, as shown by arrow. The perforation was at the point indicated by *P*, near the cardiac side of the ulcer and this material was just welling its way out from this perforation. It was

FIG. 1.



AI, area of infiltration; *P*, perforation; *X*, saddle ulcer with contraction. It was a saddle ulcer on a carcinomatous base, with marked carcinomatous infiltration. This is the first carcinoma of the stomach that I have had in my experience in which there was a perforation. All within the dotted line shows dense infiltration into the ulcer-bearing area to the greater curvature, leaving only a small way out from the cardiac pocket of stomach to the pyloric pocket of stomach, as shown by arrow.

just a small opening, but on examining it the walls were distinctly infiltrated, so I concluded to cut it out, excise the perforation, for several reasons. First, to get a good view of the ulcer, where it had extended through the different walls of the stomach, and finally through the peritoneum, showing this cone-shaped extension of it, and also in order to get sufficient material for microscopic examination, and third, because I fancied I was able to close the opening better than if I attempted to close and invert this opening by purse-string suture or whatnot. So with a knife I simply went around it as is indicated by the dotted line around the opening at *P*. Of course, the incision extended through the heart of the ulcer tissue. The dotted line at *P* indicates the

line of incision around this perforation. This was taken out and then mattress sutures were put in, closing it. Several tucks were put up around the lesser curvature, where this exudate was, and over the sutured area, so if leakage occurred it would have a way out. Then rubber tissue tucks and a rubber drainage tube were passed into the pelvis and the wounds closed up around the drainage. The man had salt solution during the operation, and went off the table pretty badly shocked during the operation, but still holding his own. He soon reacted, made an uninterrupted recovery, and lived for a number of months. The microscopic examination of the section that I removed showed the infiltration around the ulcer was carcinoma. This had infiltrated all through to the back. It was impossible to do a resection of the stomach, so it was left as found, the ulcer simply being closed. The man recovered from this perforation, gained flesh, and lived a number of months, and finally died of the further advance of his cancer. By the way, it is the first carcinoma of the stomach that I have ever seen in which there was a perforation.

CASE XII.—Mr. J. K., aged forty-four; referred by Dr. A. H. Carroll; operated on June 28, 1912; duodenal ulcer.

History.—The findings in the case were ulcer, located on the duodenal side of the pylorus, and actually was a duodenal ulcer; and the ulcer was so thin that it was on the verge of perforating, and a radical pylorectomy, followed by a gastro-enterostomy, was done. The patient made an uninterrupted recovery and has been restored to perfect health.

CASE XIII.—Mrs. T. P., aged thirty-two; referred by Drs. Oscar B. Beer and J. M. King; operated on October 12, 1912; duodenal ulcer.

History.—She came in with a history of longstanding upper abdominal pain and indigestion, and it was thought possible in this case that the case was one of gall-stones. At operation it was found to be a duodenal ulcer, situated about ¾ of an inch from the pylorus; that is, on the duodenal side of the pylorus, and on the anterior wall of this portion of the duodenum, the most common site of the ulcers in this area. A radical extensive pylorectomy was done and my method of closure resorted to, and a posterior gastro-enterostomy was done. In this case the ulcer was likewise just on the verge

of perforation; necrosis of the bottom of the ulcer had gone through to the peritoneal coat and it was just ready to perforate. She made an uninterrupted recovery and has been entirely relieved. The last report from her was she was entirely well, able to eat all kinds of food, and enjoyed splendid health, and had an absence of her pain, which brought her to me for operation.

CASE XIV.—Mr. W. I., aged thirty-two; referred by Dr. B. B. Brown; operated on March 12, 1913; gastric ulcer.

History.—For three or four years he had pain in the epigastric region, and he was brought to me by Dr. B. B. Brown. I operated, and here, likewise, the ulcer had gone deeply and was nearly ready to give way. A pylorectomy was done, followed by a gastro-enterostomy, with a very happy result.

CASE XV.—Mr. H. H., aged twenty-seven; referred by Dr. A. H. Carroll; operated on June 11, 1913; duodenal ulcer.

History.—He was brought to me with a duodenal ulcer. A pylorectomy was done, followed by a gastro-enterostomy. He made a good recovery.

NOTE.—Cases XII, XIII and XV in this series are cases that were found at the time of operation to be typical duodenal ulcers just on the verge of perforation, and Case XIV was a gastric ulcer on the verge of perforation, and should by rights be classified as perforating cases, because the serous coat had not given way but the necrosis in all of the cases had practically gotten through the peritoneal coat. They were operated upon and in all of the cases a pylorectomy was done, the entire ulcer-bearing area removed, the gastric and duodenal section ends were closed by my special method of closure, and a posterior gastro-enterostomy done, and all of the cases made uninterrupted recoveries. Photographs of the ulcers and full record of the cases are published in an article by me in the *Transactions of the Southern Surgical and Gynecological Association,* volume xxv, "Gastric and Duodenal Ulcers, with Special Reference to the Method of Operative Procedure Employed."

Cases XIV and XV are recent pylorectomy cases which have not as yet been reported, and simply add to this list of ulcers which have been dealt with according to my judgment in the most radical and proper way to combat such cases; namely, by pylorectomy and posterior gastro-enterostomy.

ANALYSIS OF CASES OPERATED UPON.

My record shows 15 cases. There were 11 perforations and 4 on the verge of perforation, for which pylorectomies were done just before perforation occurred. To emphasize what I said about the frequency of duodenal ulcer, it shows a greater number of duodenal than stomach. In this list there are 10 duodenal and only 5 stomach perforations. 12 of them came to operation in my service. Of the other 3, one was operated on by another operator in my services and simply a lower abdominal incision made, with drainage, but with a fatal outcome. One other I saw and advised operation, but it was declined. The patient was practically all in at the time, but an autopsy was gotten, and the ulcer located in the first inch and a half of the duodenum was found, verifying the diagnosis. The other, I saw in consultation with another surgeon, the patient was in extremis, all in. He was sent at once to the hospital and operated upon, but with a fatal issue.

The cases that recovered, except one, bear out the important fact that if aid is gotten promptly and early, the chances of recovery are that much greater. In all of the ones that were lost in my hands, they were operated on over twenty-four hours after the beginning of the perforation.

There was one of my series, the most interesting case, that came to operation several days following the perforation. I take it that he must have had slow perforation, with final overwhelming leakage, which put him in almost an extreme condition. He was so ill when he came into hospital that I hesitated whether to undertake it. He had well marked peritonitis, and several openings were made in the abdomen, and one in the flank, giving him pretty free drainage, as there was a large collection up under the liver and lesser omental cavity. His condition was such that it was thought highly probable that he would not live to get off the table, but after quite a stormy period of illness he made a very excellent recovery.

The ages in these cases varied from twenty-one up to fifty or thereabouts.

PERITONEAL AND PLEURAL ABSORPTION, WITH REFERENCE TO POSTURAL TREATMENT.

BY WALTER E. DANDY, M.D.,

AND

BY L. G. ROWNTREE, M.D.,

OF BALTIMORE.

(From the Departments of Surgery and Pharmacology, The Johns Hopkins University.)

PRACTICALLY every peritoneal surface has been utilized and every possible position assumed in postural methods of treating acute peritonitis. Though of recent origin this form of treatment has been almost universally accepted and is considered subordinate only to drainage in importance.

The basis for postural methods, as originally instituted, was v. Recklinghausen's claims (1863) of open channels or stomata, which established direct communication between the peritoneal cavity and the lymphatic system and thus afforded a ready explanation for rapid absorption of peritoneal fluids. These stomata, however, were thought to be almost exclusively limited to the central tendon of the diaphragm, and for this reason peritoneal absorption was considered restricted to this region. Though immediately accepted, v. Recklinghausen's claims were soon disputed. His observations were never substantiated and finally through the work of Kallosow (1893), Muscatello (1895), and MacCallum (1903), the stomata have been definitely proven to be artefacts; but Muscatello still maintained that the central tendon of the diaphragm was the exclusive absorbing area of the peritoneal cavity and that an intraperitoneal current carried the peritoneal fluid to this region. Although the peritoneum has since been considered a completely closed cavity, medical literature is still replete with theories and arguments based on the supposed presence of stomata.

The practical import of these claims was first evidenced by

the proposal of Clark's[1] position (1897). Although Clark recognized the fallacy of the stomata, he based his position upon Muscatello's claims of almost exclusive diaphragmatic absorption and reasoned that by elevating the foot of the bed 20°, gravity would so hasten the normal current to the diaphragm and increase absorption that it would constitute an effectual prophylactic method against an ensuing post-operative peritonitis. He thus felt secure in discarding the customary drainage. Any claims of efficiency from this position were overbalanced by the general dread of ensuing toxæmia from the rapid absorption through the supposedly sieve-like diaphragm.

As an expression of this opinion, Fowler (1900) advocated the exact reverse or sitting posture for the treatment of this disease. Fowler hoped to retard the current to the diaphragm where absorption was thought to be very high and to collect the peritoneal exudates in the pelvis, where absorption was considered minimal.

As evidenced from his original publication Fowler's position is based upon a full assumption of the then disproven claims of v. Recklinghausen. That Fowler was aware of the evidence against the existence of stomata is attested by his "full knowledge of the alleged anatomical and physiological reasons" advanced by Clark in his review of the literature. Moreover, as will be shown subsequently, peritoneal absorption is almost entirely by the blood and not by the lymph as assumed by Fowler. The whole foundation for Fowler's position has consequently been disproven.

Deprived of its scientific basis, this position becomes a purely empirical measure, its reputation and validity resting on clinical statistics alone. The inadequacy of clinical statistics is demonstrated by the manifested skepticism, which is similarly based upon statistics both with and without this position. The complexity of the conditions with so many factors inseparably involved, the great variation in the severity of the cases treated, the difficulty of classifying cases according to the loca-

[1] We are informed from a personal communication that this postural method has been discontinued by Dr. Clark himself.

tion and extent of the peritonitis, the virulence and character of the infecting organism, the individual resistance of the patient, the variety of treatments synchronously employed, necessarily subordinates the value of clinical statistics. Fowler's position, therefore, must by some chance acquire more logical reasons for its success than those given at its inception, more definite scientific proof of its value, or, failing in this, ultimately lose its place in the treatment of peritonitis.

The basis for Clark's and Fowler's positions may be regarded as *physiological, i.e.,* the supposed difference in the power of absorption of different parts of the peritoneal serosa, principally the diaphragmatic. The basis for a later addition to postural methods may be regarded as *mechanical, i.e.,* the principles are gravity and the mechanics of abdominal drainage, absorption playing a minor or negligible rôle. In this group may be placed the postural methods of Coffey and Küster.

Owing to the difficulty of gravitation of fluids into the pelvis Coffey places the patient in the lateral or a combined lateral and head elevated position in order to collect and drain pus from the flank.

Küster utilizes the ventral position. Though he apparently utilizes capillary drainage he thinks drainage is greatest where the patient is so placed that the incision is at the most dependent point.

This paper [2] is intended as a résumé of an experimental study, in which an attempt is made to establish the scientific value of postural methods of treatment. For the opportunities of this study it is a pleasure to express our gratitude to Professors Halsted and Abel.

We have attempted to determine (1) whether the dread of infected material reaching the diaphragm is justified; (2) the manner and channels of absorption from the peritoneal and pleural cavities; (3) the rapidity and relative amount of absorption from these cavities in various postures; (4) the distribution of fluids as determined by gravity.

[2] The amplified form of this communication will appear in the "*Beiträge zur klinischen Chirurgie.*"

Method of Absorption of Fluids from the Peritoneal and Pleural Cavities.—Until recently the peritoneal and pleural cavities have been regarded as integral parts of the lymphatic system, though the manner of absorption of the contained fluid was not clear. v. Recklinghausen (1863) first claimed open communication through stomata as mentioned above. Almost synchronous with the refutation of the existence of these stomata, doubt was thrown upon the lymphatics as absorbents of these fluids. Starling and Tubby (1894), Heidenhain (1896), and Hamburger (1895), working independently and along different lines, concluded that absorption was into the blood and not into the lymphatics. Starling and Tubby injected indigocarmine and methylene blue into the peritoneal cavity and found these colors in the urine long before they appeared in the lymph dripping from the thoracic duct. Later the colors were detected in the blood before the lymph. Heidenhain was unable to find any augmentation in the lymph flow following injections of large quantities of fluids into the peritoneal cavity. Hamburger demonstrated that the effect of poisons was not delayed by ligature of the left innominate vein, including the thoracic duct.

Muscatello and Meltzer have been the strongest exponents of lymphatic absorption. Muscatello's observations, however, were principally upon granules. Meltzer repeated the experiments of Starling and Tubby and noted the colors in the lymph before the urine. Mendel (1898) performed the same experiments and completely vindicated the claims of Starling and Tubby.

Our results are thoroughly in accord with those of Starling and Tubby, and Mendel. We have utilized phenolsulphonephthalein as the solution injected into the peritoneal cavity. This inert soluble chromogen is very stable, can be quantitatively estimated with accuracy in the urine. The excretion of phenolsulphonephthalein by the kidney is so rapid and so uniform under normal conditions that it may be treated as a constant. The urinary output represents absorption, minus a constant, and therefore negligible renal factor.

The results following intraperitoneal injections of phenolsulphonephthalein may be summed up as follows:

1. The appearance time in the *blood* is 2–4 minutes.

2. The appearance time in the *urine* is 4–6 minutes.

3. The appearance time in the *lymph* (thoracic duct) is 20–60 minutes.

4. The quantitative output in the *urine* for 1 hour is 40–60 per cent.

5. The quantitative output in the *lymph* for 1 hour is less than 0.1 per cent.

It can therefore be seen that the lymph plays practically no part in the absorption of these fluids. This is true irrespective of the position in which the animal is retained following the injection. The results are almost identical from the pleural cavity. Absorption of fluids from these cavities is therefore similar and almost entirely by the blood.

Absorption of Granules from These Cavities.—The manner of disposal of granules injected into these cavities has been much discussed. V. Recklinghausen thought their exit was rapid and through open channels. Dubar and Remy (1882) and Maffucci (1883) thought the granules were slowly taken up by both the blood and lymph. Muscatello (1895), though disproving the stomata, asserts that the absorption is lymphatic, rapid and limited to the central tendon of the diaphragm. Küttner (1903) thinks absorption of granules lymphatic and limited to the diaphragm, and upon this basis makes some very interesting clinical applications. We are indebted to MacCallum (1903) for a more rational understanding of the manner of absorption. He showed that foreign material is removed from these closed cavities by a very slow reactive process of phagocytosis, but most remains in the peritoneal cavity, to be encapsulated as foreign material. In our experiments we have been impressed with the extreme tardiness of granular removal from these cavities. After 2–3 hours few granules were found in the lymphatics or abdominal viscera, and at the end of this time granules were not observed in the lymph flowing from a cannula in the thoracic duct. It should be emphasized that

the conditions of absorption were practically normal. No artificial pressure was used and the absorption was entirely ante mortem, thus obviating very serious objections. On account of the small amount of granular removal and the non-injection of lymph-vessels, we have been unable to throw any additional light upon the path of absorption of granules whether into the capillaries of the blood or lymph. Certainly there can be no stomata or free access to the blood or the lymphatics of the diaphragm or elsewhere, for granules of india ink or other granules of similar size.

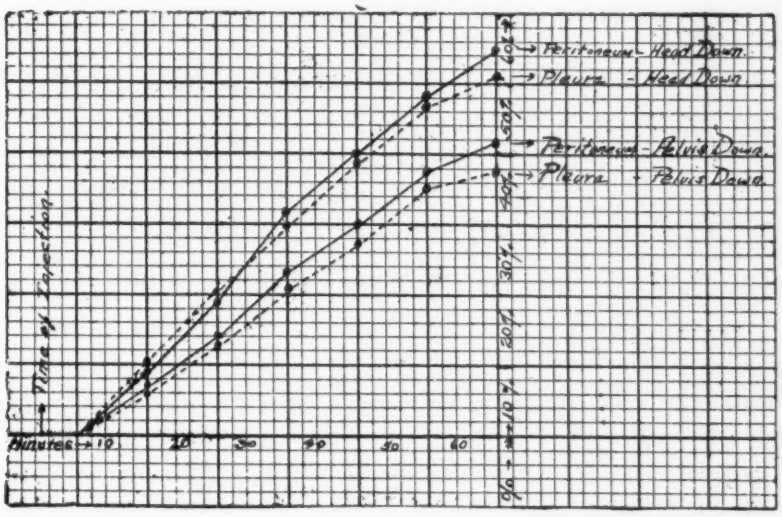
Absorption of Bacteria and Toxins.—Danielson, Wells and Johnstone, and Ruxton and Torrey have studied absorption of bacteria and have shown that practically immediately after injection of 4000 million bacteria as high as 35,000, and 5 minutes later as high as 200,000 per c.c. could be obtained in the blood. They think the absorption is lymphatic, but when we consider the tardiness of lymphatic absorption either of fluids or solids as shown above, it would not appear that the lymphatics could be considered such an exclusive factor in the absorption of bacteria, at least from the normal peritoneal cavity.

Oppenheimer has shown that toxins injected into the peritoneal cavity appear in the urine in 15 minutes, and that their absorption is not delayed by ligature of the thoracic duct. Injection of toxins by Hamburger produced toxic effects equally as rapidly and as thoroughly after elimination of the thoracic duct.

We can only conclude from a summation of the above experiments that lymphatic absorption of fluids from the peritoneal and pleural cavities has been greatly overestimated and that this absorption is almost exclusively hæmic. While our results have been mainly with fluids we feel that the results obtained by other authors on absorption of bacteria and toxins are so similar as to warrant the assumption that they are similarly absorbed from the normal peritoneal and pleural cavities. How far this is true for all such substances we are unable to say, the present status of the lymphatic system being very ill defined.

Absorption from the Normal Peritoneal Cavity in Various Postures.—A priori, it would appear grossly improbable that from over 17,000 sq. cm. of peritoneal serosa of practically uniform structure (an area equal to the cutaneous surface) only a small area representing the central tendon should accomplish even the greater portion of absorption of either fluids or solids. Nevertheless, such is the impression widely preva-

FIG. 1.



A composite curve depicting the quantitative absorption of phenolsulphonephthalein from the peritoneal and pleural cavities in canines, in the head-up and head-down positions, over a period of 1 hour, and taken at 10-minute intervals. The head-down position may be taken as representative of the ventral and dorsal positions also.

lent, and it is based principally upon the observations of v. Recklinghausen previously mentioned. Yates tested the absorption of toxins in canines in the horizontal, head-up (30°), and head-down (30°) positions. His work very clearly shows the lethal effect of cobra venum to vary only within narrow limits, regardless of the position assumed, an observation which should demonstrate the fallacy of exclusive diaphragmatic absorption.

By utilizing phenolsulphonephthalein and quantitatively estimating the excretion in the various postures, we feel that this impression may with certainty be proven or disproven and

its consequent bearing upon the postural treatment of peritonitis definitely demonstrated.

We have injected into the peritoneal cavity of dogs 20 c.c. of isotonic salt solution containing 0.6 mg. of phenolsulphonephthalein and have determined the time of appearance and the quantitative output in the urine, the animal being retained in a given position for a period of one hour.

In estimating absorption in the various postures we have no reason to assume that the parietal serosa absorbs more than its share of fluid. The collargol injections show that fluids are partly detained in the intestinal interspaces so that undoubtedly the visceral peritoneum and the omentum perform a large part of this function, but as to its relative participation it is as yet useless to conjecture. For practical purposes this is immaterial. We are concerned rather with the amount of peritoneal absorption in any given posture assumed in the treatment of peritonitis.

An analysis of these results is as follows:

1. There is very active absorption from the peritoneal cavity in all postures (40–60 per cent. in one hour).

2. The absorption in the head-down (diaphragm)[3] position is practically the same as in the ventral and dorsal positions. Consequently on the basis of absorption there is no evidence of an intraperitoneal current to the diaphragm.

3. The absorption in the pelvis-down position is definitely (15 per cent.) less than in the other three positions. For this fact we have no adequate explanation.

Absorption from the Normal Pleural Cavity in Various Postures.—Experiments of the same kind have been carried out for the pleural cavity. The results are strikingly similar in every way to those obtained in testing absorption from the peritoneal cavity. The appearance time and the quantitative output are practically the same. Very curiously the same dis-

[3] The earlier experiments showed such a parallelism in results in ventral, dorsal and head-down (diaphragm) positions that the diaphragmatic was arbitrarily chosen as representative of all three positions, to contrast with the pelvic which seemed to be definitely low.

FIG. 2.

The effects of gravity on the distribution of intraperitoneal and intrapleural fluids. 20 c.c. collargol injected 15 minutes previously; canine maintained in vertical, head-up, pelvis-down position.

FIG. 3.

Position reversed for 15 minutes after taking X-ray picture (Fig. 2). Now in head-down position 15 minutes. Note shifting of collargol from lower to upper half of abdomen and complete change in pleural fluid, the latter change being practically instantaneous. Also note effect on shape of thorax and abdomen.

crepancy in absorption is present in both the peritoneal and pleural cavities, *i.e.*, absorption is practically equal in all positions except the vertical, head-up position, in which it is definitely less (13 per cent.). We are also at a loss to explain this upon any histological or anatomical grounds.

The Influence of Gravity on Fluids in the Peritoneal and Pleural Cavities.—From the stand-point of operative treatment it is important to know if, by posture, infectious products can be segregated in selected areas where drainage is easier, the environment more propitious, and the subsequent complications of less importance. Naturally the most suitable location from these points of view is the flank or pelvis and the least suitable is the upper abdomen. Opinion is divided as to the effect of gravity on the localization of fluids in the abdomen and thorax.

By injecting collargol into the peritoneal and pleural cavities of dogs and later making an X-ray examination we have been able to observe the effect of gravity on fluids in these cavities. These examinations demonstrate that gravity exerts a very important influence in determining the localization of fluids. In the pleural cavity gravitation is practically instantaneous, in the peritoneal it is slower, its course being retarded and the direction influenced by the intestines. There is no evidence of an intraperitoneal current to the diaphragm.

CONCLUSIONS.

1. There is very active absorption of fluids from all parts of the normal peritoneal and pleural cavities.

2. This absorption is essentially hæmic and not lymphatic.

3. We have quantitatively determined the absorption of fluids in both cavities in the four postures.

4. Peritoneal absorption is practically equal in all postures except pelvis-down, in which it is 15 per cent. less than in the others.

5. Pleural absorption is practically equal in all postures except pelvis-down, in which it is 13 per cent. less. The explanation of these findings we are unable to give.

6. The visceral peritoneum undoubtedly plays an important

part in absorption—probably a more active part than the visceral pleura.

7. We have no evidence to support the view that there is an intraperitoneal current to the diaphragm.

8. There is no evidence in favor of the claims that the central tendon or the diaphragm as a whole performs more than its proportional amount of peritoneal absorption.

9. Gravity has a decided influence upon the localization of fluids—rapid in the pleural cavity, much slower in the peritoneal cavity. The intestines delay and influence the gravitation of fluids in the abdominal cavity.

10. From the above, we conclude that though Fowler's position as originally instituted was based upon entirely fallacious and disproven grounds, there is herewith adduced evidence of a different character, perhaps sufficient to justify the resort at times to this postural method in the treatment of acute diffuse peritonitis. The above results tend also to support the employment of Coffey's lateral modification of Fowler's position.

SUBCUTANEOUS TRAUMATIC RUPTURE OF THE NORMAL SPLEEN.

BY ALLAN F. BARNES, M.D.,
OF CAMBRIDGE, MASS.
Visiting Surgeon to the Cambridge Hospital.

By the normal spleen is meant one that is not hypertrophied: from malaria, anæmia, neoplasms.

History.—Aristotle and Paracelsus both speak of the removal of the spleen and say that it is an organ not essential to life. It is an old belief, still prevalent, that the spleen is a hindrance in running. Carstens and Brogsitter mention instances. The latter gives interesting information of the etymology, and the history of splenectomy for rupture. The various derivations are in anatomical, physiological, and psychological senses. Anatomically from λαιὸς, lævus, left side: the French "rate" meaning of irregular, reticular structure. Physiologically from σπλὴν, attracting malignant tumors to itself.

The earliest reported splenectomies were in 1549, by Fioravanti and Zaccarrelli, and another in 1541, both successful. In the next 100 years there were various cases reported, all agreeing that the spleen was not necessary to life. In 1855 there was a great controversy in Germany over the propriety, or advisability, of splenectomy, and as Simon, the then most influential surgical authority, opposed, the operation was abandoned temporarily. Ten years later, however, it was taken up and advocated by Spencer Wells. Most of these early cases were in diseased spleens. Splenectomy for subcutaneous traumatic rupture was advised theoretically by Kücher in 1855, Küchenmeister in 1866, Mayer in 1878, and Nussbaum and Edler in 1877. John Bell classed ruptures of the spleen with wounds of the heart as to their seriousness and dangers; so that anything like successful surgical treatment of these in-

juries is fairly modern. Before 1874 the mortality of splenectomies was 90 per cent., due to lack of asepsis, faulty technic, and often operating under false indications: such as in cases of leukæmia and amyloid. Recent statistics giving all cases of ruptured spleen in the literature have been published by Bessel-Hagen, Berger, Carstens, Neck, Johnson, Hortz, and Brogsitter (Planson's work, 1909, has not been available).

Neck, in 1905, gives 73 cases of uncomplicated rupture, with a mortality of 37 per cent. Brogsitter, 1909, gives 47 cases of rupture of the normal spleen with these results: splenectomy 64 per cent. well, 35 per cent. dead; tampon 6 cases well; suture 1 case well; suture and tampon 1 case well.

The following case was admitted to my service at the Cambridge Hospital July 8, 1913:

Male, nineteen years, no previous illness. Fell 25 feet from a staging; picked up conscious and brought to accident room. Examination one hour after accident showed spare, muscular boy, with light, sallow complexion; Colles' fracture of left wrist; small abrasions on face and chest; abdomen negative. Pulse 70, temperature and respiration normal. Catheter specimen of urine negative. Complains of pain in left side. Next day: pain in left *lower* abdomen, especially left inguinal region, where muscles are rather tense, and where there is tenderness on pressure extending into the small of the back. Otherwise abdomen and other examinations negative. No signs of fluid in abdomen. No vomiting. Temperature and pulse normal.

Second day: Sudden change for worse this A.M. Vomiting. Severe pain over the whole abdomen; abdominal muscles rigid; tenderness localized low down in left iliac region. *Operation.*—Ether. Diagnosis of probably ruptured intestine, with incision in median line below umbilicus on account of low localization of pain. On entering cavity a gush of dark fluid and clotted blood. Incision packed temporarily with gauze, and second incision made from costal border downward at edge of left rectus. Lower third of spleen found shattered into a pulpy mass, surrounded by blood clots and detached pieces of splenic tissue. In scooping these out with the hand a spleniculus, intact, the size of a walnut, with part of its mesentery attached, was found among the clots.

No free bleeding points seen; profuse general oozing. Three large pieces of gauze packed against wound of spleen pushing it against ribs and diaphragm. As much blood and clots as possible wiped out with gauze, and lower end of wound closed with interrupted through-and-through sutures of silkworm gut. Lower incision closed with small wick to pelvis. Intravenous salt solution; no stimulants. For 24 hours condition critical, then gradual improvement until end of twelfth day when tampons were easily removed. Discharged in good condition at end of sixth week. Blood normal. Five months after injury patient is well with no hernia at splenic wound.

In a search of the literature since the compilation of Brogsitter (1909) I have found reported the following cases of subcutaneous traumatic rupture of normal spleens (in chronological order):

1. ELIOT. Female, thirty-four. Fell 9 ft. Five hours later pulse 132, left side abdomen rigid, dulness left flank, fracture eighth and ninth ribs. Six hours after accident splenectomy. Well 55 days later.

2. LECÈNE. Male, fifty. Squeezed between wall and cart. Two hours later marked contraction of abdominal wall, especially on left, severe pain left hypogastrium with tenderness. Pulse 80. Pale. Splenectomy. Well.

3. FAGGE. Girl, thirteen. Knocked down by motor. Next A.M. abdomen rigid, tender, distended, most marked signs in upper left. No signs of fluid. Restless, pale. No diagnosis. Incision median line, liver explored first. Spleen almost torn in two. Splenectomy. Spleniculus found attached to gastrosplenic mesentery. Discharged in 6 weeks, with no lymphatic enlargements. Five months later well in every way.

4. Ross (not the case in Brogsitter). Male, twenty-one. Fell. Walked home. Pain in epigastrium and left abdomen. Twenty-four hours later severe abdominal pain, rigidity, distention; rapid, weak pulse. Hæmoglobin 48 per cent. Leucocyte count 20,000. No diagnosis. Operation, tampon. Slow recovery.

5. ELIOT. Male, forty-five. Run over. No signs of injury. Temperature and pulse normal. End of third hour pulse up to 100, little pain, no vomiting, no shock. In 5 hours acute pain, with rigidity and dulness in left flank. Incision parallel with costal border. Splenectomy. Well.

6. LUKIS. Male, seven. Run over by van. Abdomen tender, rigid, resonant. Pain in left lumbar region. No signs fluid in abdomen. Too weak for operation. Pulse 140, irregular. Temperature 96, respiration 34, shallow. Eight hours later pulseless. Ten hours later improved. Operation, forty-two hours after admission. Lower third spleen almost separated, laceration near hilus, not bleeding. Splenectomy. Recovery.

7. CORNER. Male, nine. Fell down stairs. Vomited once. Shock on admission. Two hours later pulse down from 98 to 86, but boy "looked bad." Area of flatness over splenic region. Splenectomy. Well.

8. HOFFMANN. Male, sixteen. Fell, striking left side on iron hoop. Vomited once that night. Next day pale, slightly cyanotic. Pulse 120, abdomen distended and tender on pressure. Dulness in left flank. Diagnosis, ruptured intestine or spleen, more likely former. Median incision. Splenectomy. Well.

9. HOFFMANN. Male, eighteen. Kicked by horse in left side. Lips cyanotic. Pulse 110. Abdomen soft, not tender on pressure. Liver region sensitive. Dulness both flanks. Diagnosis, ruptured liver or spleen. Operation ten hours after accident. Median incision. Three tears in anterior surface of spleen. Suture attempted, splenectomy. Well.

10. CHAMBERS. Male, twenty-five. Run over by light trap with rubber wheels. Severe collapse. Recti rigid, general tenderness, left flank dull not changing with position. Some dulness in right flank. Operation 1 hour later. Splenectomy. Ligature pedicle with needle and catgut. Two hours later signs bleeding. Opened. General oozing from splenic bed. Packed with gauze. Fed bone marrow. Well.

11. LEITNER. Boy, twenty. Run over by wagon, jumped on again and rode for half hour; then sudden abdominal pain. Examination 4 hours later; no signs trauma, both recti rigid. Diagnosis, some intestinal injury. Operation, piece of spleen torn off; packed with hot towel; recovery.

12. VIART. Boy, nineteen. Fell 6 ft. Two hours later pale, respirations short and rapid, pulse 110, severe abdominal pain, especially in iliac fossæ. No dulness. Diagnosis, ruptured spleen; refused operation. Ten hours later much weaker, consented. Splenectomy. Well.

13. VORWERK. Male, nineteen. Splenectomy. Nine and one-half months later, can only do light work; some glandular enlargement; skin and mucous membranes pale.

14. VORWERK. Male, seventeen. Diagnosis, rupture spleen. Splenectomy 6½ hours after accident; 9 months later fine condition; general glandular enlargement to size of bean. No pallor.

15. VORWERK. Male, twenty-four. Run over. Diagnosis, rupture of liver or spleen. Median incision; cross incision to liver which was uninjured; cross incision to spleen; splenectomy. No drainage. Three months later looks pale, pain in wound; coagulation time delayed.

16. MÜHSAM. Male, ten. Run over. Pulseless, white, abdomen shows signs of much free fluid, changing with position. (No other symptoms given.) Diagnosis, rupture of spleen. Splenectomy. End of first week fever with leucocytosis of 80,000. Recovery.

17. LILIENFELD. Male, twenty-one. Fell. Soon after passed blood by urethra. Six hours later pale. Pulse 80, tender in left flank. Tension of upper abdomen; no vomiting. Diagnosis, ruptured spleen or intestine; injury to left kidney. Twelve hours after accident operation; tears in lower pole of spleen; retroperitoneal hæmatoma near left kidney. Splenectomy. No drainage. Rapid recovery.

18. BURNIER. Male, seventeen. Squeezed between cart and bus. Pale, weak, pulse 70, few ecchymoses on abdomen. Diagnosis, shock. One hour later sudden change; restless, pulse 140, respiration hurried, temperature sub-normal. Pain on both sides abdomen, more on left; some distention. Diagnosis, internal hemorrhage. Operation 2½ hours after accident; tear at hilus bleeding freely; splenectomy. Died. Autopsy shows nothing. Cause, shock plus operation.

19. CURCHOD. Male, fourteen. Fell 36 ft. Abdomen very tender, especially in epigastrium; muscular rigidity; no vomiting. Operation 1 hour after accident. Median incision. Transverse tear in anterior border of spleen. Sutured with catgut. Wound closed tight. Convalescence prolonged by lesion, probable fracture of fourth cervical vertebra.

20. FILBRY. Male. Run over. Got up himself. Two hours later pain in right clavicle and breast, and lower abdomen. Much distended and tender; liver dulness increased; pulse 76; 6 hours later vomited twice; severe pain in upper abdomen. Diagnosis, rupture liver or spleen. Spleen torn in two. Splenectomy. In splenic bed was a spleniculus. Small tampon to region. Well three weeks later.

21. JONES. Male, thirty-seven. Intoxicated; hit by cab. General abdominal pain; bruises *right* iliac region. Next day signs of internal bleeding, with distention and dulness in right flank. Diagnosis, ruptured liver. Incision right rectus; cross incision to left; splenectomy. Well.

22. RIGOLLOT-SIMONNOT. Male, thirty-eight. Fell hitting left side on bus; got up and took next one; 15 minutes later pain in abdomen. Fainted. Six hours later cold extremities. Pulse 110, abdomen contracted, very tender; dulness both flanks. Median incision. Splenectomy. Drained. Well.

23. NAST-KOLB. Male, thirty-eight. Kicked in left chest. One hour later, tender swelling left breast, slight muscular rigidity upper abdomen; pulse 84. In evening vomited once. Second day, abdomen soft. Third day, vomited once, pulse and temperature normal. Fourth day, wants to get up; while straining on bed-pan sudden collapse; dulness in splenic region, vomiting. Diagnosis, ruptured spleen. Splenectomy. Died in 4 hours. Autopsy, intense anæmia of all internal organs. No coagula in tears of spleen, no separation of capsule.

24. CHARRIER and BARDON. Male, eighteen. Run over by wagon wheel. Intense pain in left hypochondrium, very thirsty, no vomiting. Fourteen hours' later, dyspnœa, pale, groaning with severe pain, abdominal muscles tense, especially on left, slight dulness iliac fossæ. Diagnosis, abdominal accident. Operation 16 hours after accident; splenectomy; Discharged 35th day.

25. STRAUSS. Male, seventeen. Fell 10 ft. In bed 4 days without treatment; pain in left side; sent to hospital in wagon, ¾ hour ride; not admitted; returned 3 days later by foot and tram; pain in left side, flatness up to angle of scapula, otherwise negative; in bed 2 days. On fourteenth day got up, collapsed; vomited, rapid pulse, abdomen distended and tender; by rectum a tender swelling—punctured, gave dark fluid blood. Diag-

nosis, mesenteric embolus. Laparotomy; splenectomy. Very deep tears filled with thrombi. Well.

26. CLARKE. Man, fifty-two. Seen two days after fall; pain in epigastrium, some distention, dulness left flank. Exploratory laparotomy; splenectomy. Well. Fed bone marrow and sheep's spleens.

27 and 28. McCOY. Two cases splenectomy following rupture; well 16 and 17 months after.

29. KAHN. Male, eleven. Fist blow left side, 2 hours before entrance. Collapse, with severe pain in *right* hypochondrium. No vomiting. Pulse 126–150, temperature 98.6, respiration 36, marked abdominal rigidity, shock, no dulness on left. Operation 1 hour after admission. Median incision; jagged tear in upper pole of spleen; packed with gauze; removed eighth day. Well.

30. RAIT. Male, thirty-two. Blow 3 hours before entrance. Pulse 76, shifting dulness is only marked symptom of abdominal trouble. Grew rapidly worse during preparations for operation. No diagnosis. Median incision; splenectomy. Well. Spleen showed one tear 1 in. long in lower margin; normal size and appearance (Calcutta).

31. Author's case.

This summary includes all the cases reported in this classification from 1909 to November, 1913, except the following, which have not been available, and may or may not be ruptures of the normal spleen: Okinskivich, *Med. Obozr. Msk.*, 1907, lxviii, 889; Oller, *Rev. Spec. Med. Madrid*, 1909, xii, 417–424; Mallett, *Med. rev.*, xvi, 321; Vaccari, *Ann. di med. nav. Roma*, 1909, ii, 533; Kopiloff, *Khir. Mosk.*, xxx, 614; Lindstrom, *Nord. Med. Arch. Stockholm*, 1911, ix, 80; Steinthal, *Med. Cor. Bl. d. würtem. ärtzl.*, 1911, lxxxi, 190; Wille, *Norsk. Mag. f. Laegevidensk*, 1911, 5, R, ix, 722.

Of these 31 cases reported 26 were treated by splenectomy with 2 deaths, a mortality of 7.6 per cent.; Brogsitter's collection showed 34 splenectomies with 12 deaths, a mortality of 35.3 per cent.; progress in surgery or a decline in reporting bad results? Four treated by tampon and one by suture with no deaths. Brogsitter's figures here were respectively 6 and 1 with no deaths.

Etiology.—There are various theories to account for these subcutaneous truamatic ruptures in health. A large percentage of them occur in children, workingmen, and young adults, as naturally they are more exposed to injury. And yet

the small percentage (13 per cent. Berger) in men over fifty, with whom falls and blows are usually serious, suggests the possibility that there may be some anatomical or physiological cause of the frequency of this accident in the young.

Nearly half of all subcutaneous ruptures are in diseased, enlarged spleens (Berger), where they may be said to be hyperfunctionating. The frequency of such cases not reported, especially in malarial countries, is shown by a report of Sutherland of judicial autopsies in the district of Saugor (India), where from 1900–1908, of 295 deaths 27 were from ruptured spleens, most of them twice the normal size.

Hoffmann suggests as a cause of rupture in health the greater pliability of the sternum in the young; transmitting the force of the blow, where in the old there is more resistance and fractured ribs result. Berger's theory is hydraulic pressure; comparing the spleen to a vessel full of fluid, which it practically is. Spontaneous ruptures, during pregnancy or confinement, in all of which there has been enlargement, mostly from malaria, and ruptures of enlarged spleens from a very light blow, can hardly be explained otherwise. Johannson quotes the experiments of Petersen, who was unable to rupture normal spleens with a hand pump, while those diseased gave way readily. Brogsitter gives most importance to the splenic ligaments; and supposes a deep inspiration occurring reflexly with the blow. Probably there are factors in all these ideas. To put it as simply as possible: surrounded by the ribs, diaphragm, ligaments more or less tough and always resistant, kidney, pancreas, stomach and intestines often filled with food, is a very friable organ, built like a sponge of connective tissue and a few unstriped muscle fibres, filled with blood, at a pressure of 120–150 mm. of mercury, and covered with a fibrous capsule. The transmitted force of a blow or fall finds it less resistant than its neighbors.

Signs and Symptoms.—Pain is the first symptom; from a blow, more likely to be localized in the splenic region; after a fall, more frequently felt all over the body, or through the

entire abdomen. Occasionally the pain is localized in a misleading area, as in my case and that of Rendle, in the left iliac and inguinal region, and Viart's entirely in the lower abdomen. In 4 of Vorwerk's 8 cases there was no localized pain. With more or less rapidity (1 hour—14 days) follow signs of shock or bleeding—it is often impossible to tell which if they appear early, but the pulse remains at first better than the amount of pallor would lead one to expect in shock. In cases of *rapid* bleeding the classic signs of internal hemorrhage are clear enough to establish that diagnosis. The one most important sign is the rigidity and tension of the abdominal wall (though it may occur without any internal lesion). This was emphasized over 100 years ago (Vorwerk cit.) by Baillie, who speaks of a "dureté cylindroide"; also by Vigla in 1844, the "ventre dûr rénitent." With this rigidity is tenderness and spasm on pressure. The rigidity is apt to be diffuse, at first, the tenderness more often localized. Ballance's sign I find to be the least consistent in all the reported cases. It helps if present, but may be obscured by distention with tympany, and blood lodging elsewhere than in the flanks. Pitts and Ballance give as symptoms: 1, Local injury; 2, evidences of local internal hemorrhage; 3, increase of fixed splenic dulness; 4, both flanks dull on percussion, the right flank alone becoming resonant with change of position. The very frequent absence of this last sign needs to be emphasized, because, first, one would theoretically expect it, and, second, because so much importance has been attached to it in the literature. Rieger, Eichel, Notzel, Roser, and West (Brogsitter cit.) all say that there is usually no increase in splenic dulness. Brogsitter makes a point of the absence of vomiting; and the reported histories seem to bear out the importance of this observation. There was vomiting mentioned in only 6 of the 31 cases collected here; in my case there was no vomiting until the second day; in one case it came on early; once at 8 hours; once at 12 hours; once not till the fourteenth day. Rohrbach, on the other hand, would count absence of vomiting in favor of contusion rather than rupture. Vomiting

means a serious injury, but its absence, together with abdominal muscular rigidity, favors a rupture of the spleen rather than a ruptured stomach or intestine. Levy and Shulze speak of pain radiating to the left shoulder, but it is seldom mentioned in reported cases.

It is surprising how little attention has been paid to the leucocyte count as an aid in the diagnosis. I recollect only one case (No. 4) in all those I have read over where it was mentioned (before operation). In my case no count was made until the appearance of severe symptoms on the second day, when it was found to be 30,000. Theoretically one would expect a steadily rising leucocytosis after the injury.

Diagnosis.—An accurate diagnosis is rarely possible. The history of an abdominal blow or a fall, followed by tension of the abdominal muscles and the beginning of the signs of hemorrhage, should be enough for an exploratory incision; preferably under local anæsthesia as recommended by Trendelenburg, Mickulicz, Pauchet, Georgi, Petzow, Krabbel, Simpson, Notzel (Rohrbach cit.). Lemerenz in 30 cases found that an accurate diagnosis had been made in 5, and in the 31 cases here it is mentioned as made correctly in 4. A diagnosis of ruptured liver or spleen is frequent.

Treatment.—The mortality in unoperated cases is 94 per cent. in normal spleens, and 90 per cent. in those diseased; average 92 per cent. (Berger). There are a few records of cases at autopsy showing old tears healed by clots, and there are two specimens showing this in St. Bartholomew's Hospital museum (Lukis). The three commonest methods of treatment in order of frequency have been: 1, Splenectomy; 2, tampon; 3, suture. The statistics of results are *all* splenectomies to 1890, 42 per cent. mortality; 1891–1900, 18.9 per cent. mortality (Bessel-Hagen). Brogsitter (1909) in all reported cases of traumatic rupture of *normal* spleens finds 35 per cent. mortality; and the cases since 1909 collected here give 6.4 per cent.

Other methods of treatment such as ligature of the splenic vessels, magnesium wire, cautery, steam, and hot air have been

tried and need only be mentioned here. Senn's method of crushing the edges of the splenic wound with forceps, and then suturing, was successful in dogs, but any kind of suturing of the human spleen is too difficult and too uncertain, notwithstanding the success of Curchod in case No. 19 here. Sheldon, in dogs, clamped the splenic vessels for 4 hours, letting the blood in the spleen drain out, avoiding tampon and consequent thrombosis of vessels in the spleen. At the end of this time the clamps were removed and there was no bleeding. The dogs killed from 1–3 weeks later showed spleens with good circulation and no areas of necrosis. So far as I know this has not been tried in man.

Splenectomy has been the prevailing treatment, and the only one advocated by most of the writers, until Brogsitter, who realizes the value and possibilities of tamponade. This method has found more favor with American and English surgeons (4 of Brogsitter's 6 cases, and all 4 of my cases). In injuries involving the hilus of the organ, where large vessels are torn, I believe that splenectomy is still indicated.

Otherwise tamponade is the "ideal treatment," if by "ideal" we mean the method offering the best chances for a living and organically intact patient. From the point of view of surgical technic only is splenectomy the ideal form of treatment. My reasons for this view are:

1. The statistics of tamponade, admittedly few but nevertheless reassuring, are: Berger 6 cases, 1 death; Brogsitter 6 cases, no deaths; cases here 4, no deaths. A total of one death in all of the 16 cases reported to date. (A case of Brewster, omitted by Brogsitter apparently, recovered with tampon.)

2. Increased danger to the patient of adding the shock of splenectomy to the shock of his injury. The nerve supply is abundant; from the splanchnic nerves and cœlic ganglia. Tamponade is quicker.

3. Structurally and geographically the spleen is well suited to treatment of hemorrhage by tampon. With a good exposure of the operative field all tears can be felt and there need be no danger of bleeding posteriorly into the lesser cavity.

4. The possibility of lessening the motility of the stomach or colon from adhesions is not a serious contra-indication—witness the various operations such as Rovsing's.

5. The economical value of the spleen in our physiology. In spite of the cases which have lived in reported health for years without the organ—Pean's 13 years, Vulpius's 15 years, Adelmann's 23 years (Vorwerk's cit.)—the more work that is done in the physiology of the spleen the more evident it becomes that it is not an organ to be sacrificed for a few tears if the hemorrhage can be stopped in some other way. (See present work of Vogel, Asher, and Pearce.) All splenectomies show a hæmoglobin of about 70 per cent., and the presence of transitional forms of blood cells for a varying length of time; signs of a serious disturbance. Compensation is often established so slowly that patients are invalids for the first year at least. Tamponade gives a more rapid convalescence. Only a small proportion of splenectomies have been followed with sufficient care for any number of years, and experimental work has been conflicting and contradictory. Kanavel concludes from his work on dogs that non-union of fractures cannot be attributed to loss of the spleen, but in splenectomized men repair has been long delayed. Hubbard worked with guinea pigs and concluded that there was no diminution of resistance to infection from splenectomy. He reports a case of his own perfectly well three and three-quarters years after operation, and reacting normally to a quinsy throat. But other experimenters have obtained conflicting results, as shown by Danielson. What the spleen does with iron we do not know definitely; we do know that after splenectomy the formation of bile pigments is interfered with and their amount reduced; and that less trypsogen is secreted by the pancreas. A point to be remembered is that the function of the spleen varies much in different species, and one must be careful in assuming that experimental results in animals will hold good for man. There is no proof yet that splenectomy in man makes him peculiarly susceptible to infections. But one cannot help feeling in studying reported cases that many spleens have been sacrificed by

splenectomy where tamponade would have stopped the bleeding.

Technic.—A median incision under local anæsthesia is the best, as the diagnosis is usually uncertain. From the upper end of this incision a cross incision, following the border of the ribs, gives a good field for determining the extent of the injury, and for splenectomy should it be necessary. Resection of the lower rib cartilages has been recommended by Auvray, Lejars, Lötsch, Rabinowitch, and Kocher (Brogsitter cit.), but it is probably not necessary unless the spleen is enlarged. The definite contra-indication to splenectomy is leukæmia or pseudoleukæmia.

Conclusions.—In the diagnosis, local abdominal signs (the results of hemorrhage) are seen earlier than the general signs of hemorrhage. The leucocyte count should be watched carefully in the absence of other definite signs. Make an early exploratory abdominal incision under local anæsthesia when suspicious signs and symptoms follow an injury or fall. The spleen may be ruptured with remarkably few evidences of it. Preserve the spleen if it is possible to tampon the injured area.

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HERNIA OF THE LARGE INTESTINE.*

WITH SPECIAL REFERENCE TO "SLIDING HERNIA."

BY ALEXIS V. MOSCHCOWITZ, M.D.,

OF NEW YORK,

Visiting Surgeon, Har Moriah Hospital; Associate Surgeon, Mount Sinai Hospital.

ALTHOUGH first described by Scarpa, this variety of hernia did not receive much attention until the French surgeons began to study the subject. The German articles are few and far between, although an excellent article on the subject has been written by Sprengel (*Archiv f. klinische Chirurgie,* vol. 95, page 702). In this country Weir (*Medical Record,* February 24, 1900) gave the subject an excellent résumé, and published cases of his own.

Judging by a personal experience, this form of hernia is of more frequent occurrence than one would be led to assume by the number of cases reported. This can be accounted for in two ways; either the hernia has not excited sufficient interest in the operator, or (which in the writer's opinion is more likely) the operator did not wish to be reminded of a rather unpleasant experience.

The operation for the radical cure of a hernia of the large intestine may be one of exceptional difficulty; it is important, therefore, that the surgeon bears the possibility of its presence constantly in mind. He must, in addition, be well acquainted with all the forms and possibilities of such a hernia, inasmuch as considerable, and often irreparable damage may be done.

The five divisions of the large intestine, viz., cæcum, ascending, transverse and descending colons and the sigmoid flexure, all have their peculiarities when met with in a hernia; it is necessary, therefore, to discuss each division separately.

Before proceeding to the individual description of these

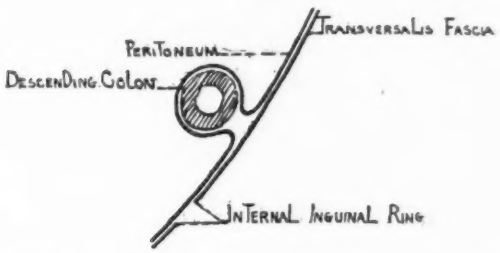
* Read before the New York Surgical Society, Dec. 10, 1913.

subvarieties, it is necessary to call attention to a phenomenon peculiar to herniæ of certain portions of the large intestine.

This phenomenon has been called by the French "hernie par glissement," or translated into English, "sliding hernia."

It is difficult to give a short description of this phenomenon;

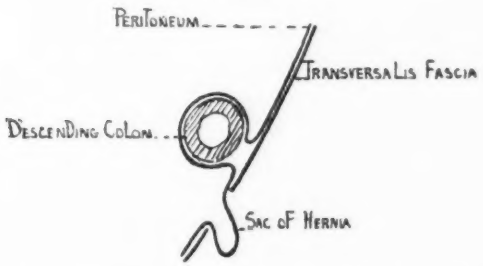
FIG. 1.



Sliding hernia of descending colon by "pulling" mechanism. First stage.

but a clear mental picture of this hernia can be obtained in the following manner. Let us imagine, for instance, that the peritoneal attachments of the descending colon have become loosened from the subjacent structures, so that the colon, instead of being a fairly fixed structure, now moves easily in

FIG. 2.

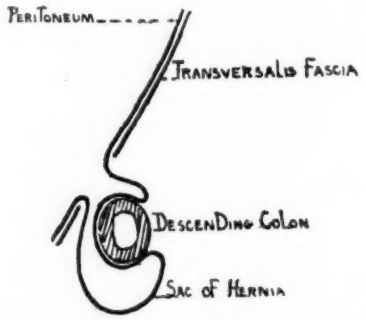


Sliding hernia of descending colon by "pulling" mechanism. Second stage.

its bed; let us then imagine, that the peritoneum in the neighborhood of the internal inguinal ring is grasped, and then pulled in the direction of the scrotum. What will happen under these circumstances? First, a hernial sac is being pulled out, and eventually the sigmoid flexure and descending colon. The successive steps of this procedure are illustrated in Figs. 1–5.

The sigmoid flexure, being covered on all sides by peritoneum, does not necessarily differ from a loop of small intestine, but the descending colon is usually covered only on three sides by peritoneum; it is evident, therefore, that after being

FIG. 3.

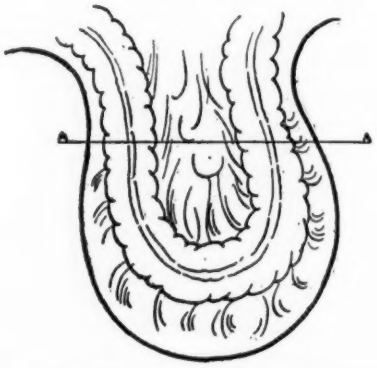


Sliding hernia of descending colon by "pulling" mechanism. Third stage.

pulled down, the descending colon will form part of the posterior surface of the sac. This is one variety of sliding hernia, and may be termed a " sliding hernia by pulling."

Let us now imagine the following. For the purpose of

FIG. 4.

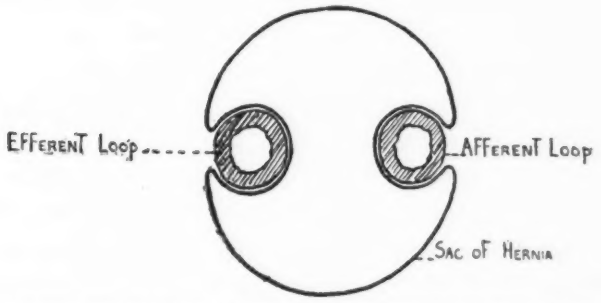


Sliding hernia of descending colon by "pulling" mechanism.

our experiment, the descending colon has again been loosened, as in the preceding assumption. Let us now suppose that pressure or force has been applied over the descending colon, just above its junction with the sigmoid flexure; the direction of this

force must be first backward, then downward and inward, toward the internal inguinal ring. What happens under these circumstances? First, the anterior wall of the descending colon is approximated to the posterior wall; the force continuing

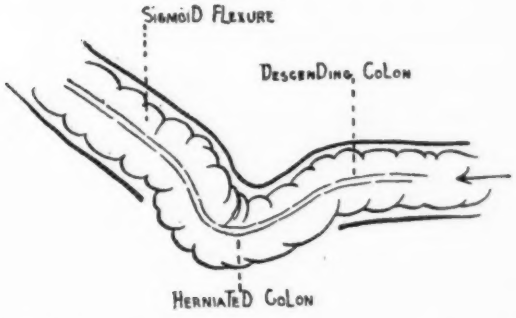
FIG. 5.



Diagrammatic cross-section of sliding hernia of descending colon by "pulling" mechanism. Section made at *AA* in Fig. 4.

against the posterior wall, this segment of the descending colon is pushed nearer and nearer to the internal inguinal ring, until finally it is pushed out behind the peritoneum into the inguinal canal (Fig. 6). We now have a true hernia without any in-

FIG. 6.



Sliding hernia of descending colon by "pushing" mechanism; so-called sacless hernia.

volvement of the peritoneum, *i.e.*, a sacless hernia. In contradistinction to the first variety this may be termed a "sliding hernia by pushing."

Both of these herniæ occur with about equal frequency. There are certain differences between the two, with which it

is well to be acquainted. Herniæ by pulling are usually very large; herniæ by pushing are very small. Herniæ by pulling usually have a very large sac; herniæ by pushing usually have no sac at all. In the herniæ by pulling, the nutrient vessels of the gut are usually pulled down with the gut; in the herniæ by pushing, the nutrient vessels need not necessarily be in the hernia.

If this pathogenesis is borne in mind, it becomes evident that only those parts of the large intestine can be involved in a sliding hernia, which are not covered on all sides by peritoneum. It is manifest, therefore, in spite of assertions to the contrary, that the ascending and descending colon are the only parts of the large intestine that can enter into the composition of a sliding hernia. Most authors speak of the sigmoid flexure as the sliding organ, but this is manifestly incorrect.

Before making a statement so radically different from the conventional view, it is necessary to define precisely what part of the large intestine is meant when we say " sigmoid flexure." Unfortunately even anatomists are not agreed, and call this part of the intestine by different names, such as sigmoid flexure, S. romanum, iliac colon, pelvic colon, S. iliac, etc., etc. The writer prefers to adhere to the orthodox nomenclature according to which the sigmoid flexure is that part of the large intestine, which has throughout its entire extent a well-defined mesentery, the mesosigma; in contra-distinction to the descending colon, which is covered only on three sides by peritoneum.

However, the distinction as to whether an organ is completely or incompletely covered by peritoneum is a very narrow one. Broadly speaking, there is no organ which is completely surrounded by peritoneum. All the organs are in fact extra-peritoneal, being merely tucked to a greater or lesser extent into a closed peritoneal sac. It also follows, therefore, that almost every organ under favorable conditions may become the sliding part of the sliding hernia. Thus, for instance, we speak of the small intestine as having a complete peritoneal investment; yet in very large herniæ upon the right side, in which the cæcum and ascending colon are pulled down, so

much of the mesentery of the small intestine may become unfolded and enter into the formation of the huge sac, that even the small intestine may appear as a sliding hernia. Similarly upon the left side, while we speak of the sigmoid flexure as having a complete peritoneal investment, the sac may be so large, that the mesosigmoid becomes unfolded, and the sigmoid flexure itself may become the sliding part. But these are rare instances; the writer has never seen the sigmoid flexure as a sliding hernia, but has seen a case of sliding hernia of the small intestine in which the hernia reached way below the knee. On the other hand, the broader the uncovered area of a viscus, the greater is the likelihood of this viscus being found to be the sliding part of a sliding hernia.

On theoretical grounds we may, therefore, divide the abdominal organs, according to their likelihood of entering into the formation of a sliding hernia, into the following groups:

Always.	Never.	Rarely.	Likely.
ureter	ovary	sigmoid flexure	ascending colon
	stomach	small intestine	descending colon
	liver	uterus	broad ligament
	spleen	Fallopian tube	bladder
	transverse colon		appendix
	cæcum		
	omentum		

Finally, the writer wishes to state, that by the above description he only refers to the sliding organ, which has nothing to do with the hernia. In other words, we may have combinations; thus, for instance, there is nothing to prevent the ovary from being in a sliding hernia of the descending colon; in such a hernia, the ovary is merely an accidental content of the hernia, but the sliding part is the descending colon only.

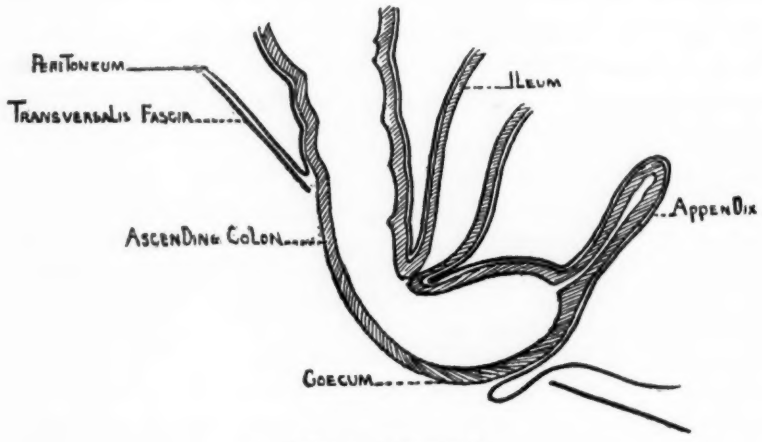
Assuming the correctness of the pathogenesis of sliding hernia that we have set forth, it becomes self-evident that the terms "hernia of the large intestine" and "sliding hernia," are by no means synonymous. This mistake is only too frequently made in medical literature.

All herniæ of the large intestine, whether sliding or not,

have certain other peculiarities, according to the organ prolapsed.

a. Hernia of the Cæcum.—Anatomists have described various forms of the cæcum. For our purpose it is sufficient to say, that the cæcum is that part of the large intestine which lies below the ileocæcal valve. Its blood supply comes from above and from the median area of the abdomen; it is, therefore, an organ which has a complete peritoneal investment. The cæcum can, therefore, never be the sliding part of a sliding hernia. It is merely prolapsed into the hernial sac, and can always be reduced with the greatest ease.

FIG. 7.



"Hernie par bascule."

When, however, it is found in combination with sliding herniæ of the ascending colon and adjoining portions of the small intestine, then its reduction may not be easy. One form of such a hernia is particularly puzzling, so much so, that the French have seen fit to give it a special name "hernie per bascule."

The pathogenesis of this hernia is the following: Let us assume a very small sliding hernia of the posterior wall of the ascending colon, at the point where this organ joins the cæcum. In the progress of the hernia more and more of the adjoining portion of the cæcum is being extruded, but a small part still remains within the peritoneal cavity (Fig. 7). We have then a small sliding hernia of the lowermost part of the posterior wall of the ascending colon; a small intrahernial part of the cæcum; and a

small intra-abdominal part of the cæcum. It is as though the cæcum was partly bent upon itself, like a hammock. This is the so-called "hernie par bascule."

b. Hernia of the Ascending Colon.—It has already been noted that the ascending colon occurs in an inguinal hernia only in the form of a sliding hernia (exception of course must be made for those isolated cases, in which the ascending colon has a complete mesentery). Furthermore, that it may occur in two different forms: first, in large herniæ, the pathogenesis of which is explained by a "pulling" mechanism; in this case the ascending colon is frequently accompanied by other viscera in the vicinity of the internal inguinal ring, viz., the cæcum, appendix, small intestine and omentum. And second, in small herniæ, the pathogenesis of which may be explained by a "pushing" mechanism; this second form may be entirely devoid of a sac, and may in consequence be very baffling. It is true, there may be a very minute sac toward the mesial side of the gut, but this is expected owing to the dislocation of the intestine.

c. Hernia of the Transverse Colon.—The transverse colon for practical purposes has a complete peritoneal investment; it is, therefore, never the sliding portion of a sliding hernia. In any event, it is a rare hernial content, and then only in those of extreme size, and when the organ is prolapsed. Being completely invested by peritoneum, its reduction never causes any difficulty.

d. Hernia of the Descending Colon.—With negligible modifications the remarks on herniæ of the ascending colon apply equally to those of the descending colon.

e. Hernia of the Sigmoid Flexure.—Most of the special articles on sliding hernia speak of herniæ of the sigmoid flexure as a type example of sliding hernia. The reasons why the sigmoid flexure, except under unusual conditions, cannot form the sliding part of a sliding hernia have already been discussed.

Treatment.—The treatment of uncomplicated herniæ of the cæcum, transverse colon, and sigmoid flexure, is no different from any other simple form of inguinal hernia.

The treatment of sliding hernia, however, *i.e.*, the treatment of herniæ of the ascending or descending colon is an entirely different proposition. There is hardly any operation that may tax the patience and technic of the best equipped surgeon more.

a. Sliding Herniæ by a "Pushing" Mechanism.—These herniæ are usually of small size. Exposure is usually very easy through the usual hernia incision. A not uncommon description of such an operation is the following. The first thing that strikes the surgeon is, that search as he may for a sac at the usual site, *i.e.*, toward the inner side of the cord, no sac is found; again and again he repeats this manœuvre, and again and again he fails. At this point he begins to doubt even the diagnosis of a hernia; perhaps the patient now reacts slightly from the anæsthetic, and coughs or vomits; and sure enough he sees a distinct hernial bulging, and so he begins all over again, with the same result. The patient again vomits or strains, and then he notices that the hernia does not come down on the inner side of the cord, but to the outer side and posteriorly. Even at this stage it is fortunate, if he recognizes by this sign, that he is dealing with a sacless sliding hernia. The surgeon who fails to recognize what he is dealing with, sure only of the presence of a hernia, boldly incises what he believes to be the sac; meets hemorrhage, the importance of which he does not appreciate, and to his chagrin, finds himself within the lumen of the gut. This graphic description need not be considered overdrawn; it occurs frequently.

The most important step in the treatment of these herniæ is their recognition. These herniæ are so small, that they can be readily pushed back, with a little blunt dissection, not into the peritoneal cavity, but into the retroperitoneal space. It is not even necessary to open the peritoneum; at most the peritoneum at the inner side of the internal inguinal ring may be incised, in order to verify the correctness of the diagnosis; the small incision can be immediately closed by a purse-string suture.

Deep sutures are passed, care being taken that the gut is held replaced during the process of tying.

b. Sliding Hernia by a "Pulling" Mechanism.—In contradistinction to the preceding variety, these herniæ are usually of large size.

A picture of the operation for such a hernia is often the following. Being of large size, the sac is easily found and incised. Various hernial contents are found, but most of them are readily replaced; but there still remains a piece of intestine, which resists all our efforts at reduction. There is more pulling, more pushing, and more violence, but this piece of intestine refuses to

budge. The sac is then incised more widely, and fortunate is both the patient and the surgeon, who even now recognizes that he is dealing with a sliding hernia of the large intestine. The operator who misses this recognition, regards the intestine as adherent, and proceeds to liberate it; he divides the peritoneum on one or the other side of the intestine; soon considerable hemorrhage is encountered, which is interpreted as coming from vascular adhesions. What has really happened is, that the vascular supply of the prolapsed gut is being cut off. After sufficient gut is liberated, a finger is passed into the peritoneal cavity; the continuation of the gut is felt, and is interpreted as the continuation of the adhesions. If the liberation of the intestine is further proceeded with, the lumen of the gut may be entered. The gut is finally reduced in a slipshod manner, and the sac tied off in an equally slipshod manner. If only a small piece of the intestine has been thus deprived of its arterial supply, the anastomotic circulation may be sufficient to restore vitality; if, however, a large piece of the gut has thus been deprived of its arterial supply, or if the ligatures were placed too close to the gut, beyond the last anastomotic arches, gangrene may result, and the patient dies from a perforative peritonitis.

The surgeon who knows proceeds differently. When he finds that there is difficulty in reducing the last piece of intestine, he incises the sac more liberally, inspects this piece of intestine, and finds here and there upon its surface small pieces of fat, which he recognizes as epiploic appendages; further inspection will also reveal to him upon the surface of the gut, at least one longitudinal band; both points absolutely indicative of large intestine. He does not look upon it as an adherent loop of intestine, but correctly diagnosticates it as a sliding hernia of the large intestine and proceeds to treat it as such, in the following manner. The method was first suggested by Hotchkiss (ANNALS OF SURGERY, vol. 50, page 470) and amplified by Walton (ANNALS OF SURGERY, vol. 57, page 86).

Assuming that the incision of the sac was properly made in the centre of its anterior surface, the incision is then extended the full length of the sac. Its liberation is proceeded with cautiously; first the spermatic cord is encountered and dissected away; the liberation proceeds further and further (and is quite easy, if it has been started in the proper line of cleavage), until the

hernial sac, the herniated intestine, plus its blood-vessels, are lifted up from the posterior wall of the hernial space. None of the blood-vessels should ever be injured, if this dissection is properly done. The sac is thus liberated on both sides, but far more freely on the outer side.

The intestine and sac are now held up perpendicularly, when it will be seen, that on both sides of the intestine the sac drops down over the nutrient vessels; the sac is now fastened here and there by an interrupted stitch; when this is done, it is seen that we have made a sort of an artificial mesentery for the intestine. If the liberation of the intestine and vessels has been properly done, there should be no further trouble in reducing the intestine. The remainder of the sac is now closed by a running suture, as a ligation is evidently an impossibility. The radical operation of the hernia is now proceeded with in the usual manner. Throughout the operation it must always be borne in mind that the vessels enter from the mesial side of the gut; particular care is therefore necessary not to injure them.

In one case the writer attempted the following procedure for the cure of a sliding hernia, after the diagnosis of a sliding hernia by the "pulling" mechanism had been established. The inguinal incision was temporarily packed with gauze. A separate abdominal incision was made; in the Trendelenburg position the colon was now pulled back into the abdomen, and fastened to the posterior abdominal parietes, by sufficient interrupted stitches of silk (colopexy). After closure of the abdominal incision, the redundant part of the hernial sac was freed and extirpated, and the radical part of the operation finished in the usual manner. The writer has since learned that the Lardonnois had previously suggested a similar procedure.

LOOPING THE CARDINAL LIGAMENTS IN UTERINE PROLAPSE.*

BY ARTHUR J. NYULASY, M.R.C.S. (Eng.),
OF PERTH, WESTERN AUSTRALIA,
Gynæcologist to the Perth Hospital.

THE multiplicity of operative procedures for prolapsus uteri indicates to some extent the uncertainty of opinion as to the essential cause of the condition. Could this be placed upon a completely satisfactory basis, the surgical treatment of uterine prolapse should at once become direct and definite. Assuming, as we obviously must, that the supports of the uterus have in some way been injured to permit of its downward displacement, the surgical treatment should take the form of a complete or approximate restoration of the injured parts to their normal state. If so much be granted, we must, in any attempt to evolve a rational surgical treatment, proceed to discover, if possible, what actually are the supports of the uterus.

A study of the literature of the subject reveals that the pelvic diaphragm is commonly regarded as the principal support of the uterus, and that the ligaments are considered of secondary value as supports of the organ, one writer going to the length of referring to the theory, that the ligaments are the primary supports, as being "antiquated." As opposed to this latter attitude Emmet long ago drew attention to the fact that the pelvic diaphragm might be lacerated up to the bowel without indication of downward displacement of the uterus, even in the presence of strenuous physical work. And I can recall a case in the Perth Hospital in which, in spite of some incontinence of fæces due to an old perineal laceration extending into the sphincter ani, there was not the slightest indication of uterine prolapse, although the patient was accustomed to do a big washing once a week. In this case, too, even

* Read at the Australasian Medical Congress, Auckland, New Zealand, February 13, 1914.

when the vagina was widely opened up by a broad posterior speculum, the uterus could be drawn down with a vulsellum no further than in the normal female, and at once retracted on relaxing the vulsellum. These facts suggest that although the pelvic diaphragm may be an important element in supporting the uterus in the pelvis, it may not have that primary influence many would have us believe. It is to be noted in this connection that some surgeons, who in their theories treat the uterine ligaments with scant courtesy as supports, yet do not hesitate to make use of those ligaments as an important part of their operative procedure for uterine prolapse. Thus, it is not uncommon for them to recommend the curtailment of the round and uterosacral ligaments. It would doubtless be urged that the object of shortening these anterior and posterior ligaments was largely, if not entirely, to cause the uterus to rest upon the bladder in its normal position of anteversion, and thus place it at an advantage as far as the influence of intra-abdominal pressure is concerned. And, although to some extent this explanation would be valid, it would, I think, be a closer approximation to the truth to say that these tightened-up ligaments *support* the uterus in its newly-restored anteverted position, and thus encourage the lateral ligaments of the uterus (cardinal ligaments) to gradually contract and strengthen by physiological rest.

In what might, for convenience, be termed the English school of treatment of prolapsus uteri the round ligaments are curtailed, or some form of hysteropexy carried out, with perhaps a curtailment of the uterosacral ligaments, followed or preceded by some form of colpoperineorrhaphy. The American school long ago attacked by the vaginal route the tissues in the broad ligaments—elytrorrhaphy—a procedure which has been elaborated by Reynolds, Hertzler, and others with some degree of success. And some of our Continental brethren have turned the uterus nearly upside down, or otherwise put it into unnatural positions, or have carried out elaborate procedures on the vagina. By all these various measures more or less satisfactory results have been claimed. But in contemplating this bare outline of the multitudinous operations which have been advocated,

one cannot but realize that they cannot *all* be founded on the only rational basis of treatment—seeking out the essential cause and directly attacking it.

The only operative procedure for uterine prolapse which seems to me to bear the light of rigid investigation is that which directly deals with certain tissues (in the broad ligaments) passing out from the sides of the uterus. These structures—the cardinal ligaments—I have no doubt whatever are the main element holding the uterus at a more or less definite level in the pelvis. Their supporting power is illustrated in vaginal hysterectomy (in a normally-fixed uterus), when all supporting elements except the broad ligaments have been completely severed. At this stage in the hysterectomy the uterus can only be drawn down by a vulsellum in the cervix exercising some force, the resistance to this force being the pull of the cardinal ligaments on the uterus. When the vulsellum is released, the cardinal ligaments, pulling on the uterus, draw it back to its original position.

The cardinal ligaments can be readily demonstrated in the abdomen of the dead subject by turning the bladder down from the uterus. They commonly arise by three more or less definite heads from each side of the uterus, the middle head corresponding to the position of the uterine artery, the interior head being attached to the upper surface of the lateral vaginal fornix, and the superior head being attached a little above the median head. G. Reynolds and E. C. Dudley lay stress on the important part the vaginal attachment of the tissues in the broad ligament plays in holding up the vagina, bladder and rectum. Thus, according to Dudley, " . . . the fact that vaginal hysterectomy commonly results in holding up the pelvic floor, and with it the rectum, vagina, and bladder, is because the broad ligaments are fixed in the vaginal wound." The three heads of the cardinal ligament unite together to form a band about half an inch or more in width, which passes outward for over an inch between the layers of the broad ligament. The cardinal ligament, which up to this is largely muscular, now tends to change its character, sending off fibrous bands, fanwise, to the wall of the pelvis and other parts, some of these bands, it is to

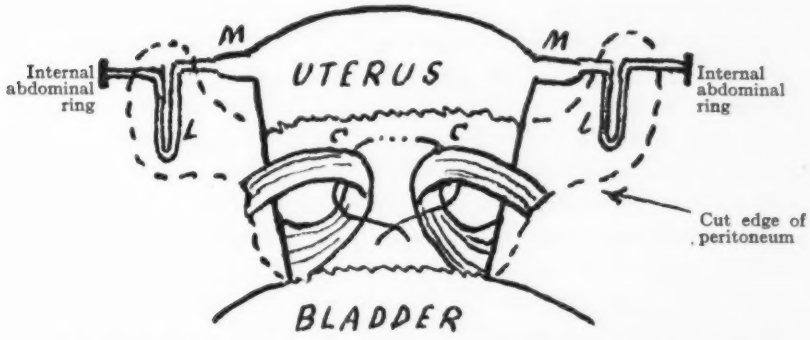
be noted, being inverted into the posterolateral wall of the bladder and others passing up over the iliacs. After locating the ureter, the cardinal ligament may be dissected from the posterior peritoneal layer of the broad ligament, and thus completely isolated. Hooking the ligament up on the finger it is found to be elastic, and of considerable strength, and obviously quite capable of adequately supporting the uterus in the pelvis. For his valuable help in the final dissections, before completing this paper, I have to thank Dr. C. Kellaway, Registrar to the Melbourne Hospital.

During a recent visit to Melbourne I was enabled to make further dissections verifying those already made in Perth, although much still remains to be done in connection with the cardinal ligaments. However, in spite of the comparative limitations in this regard in Perth I felt justified, in papers to the Australasian Medical Congresses of 1908 and 1911, in laying down certain premises which appear satisfactory as working propositions. In the second paper I sketched out my present operation of looping the cardinal ligaments. The propositions referred to are: (1) that the uterus is sustained in its normal position in the pelvis by its ligaments, although capable of a certain range of movement on account of the elasticity of these ligaments; and (2) that the pelvic diaphragm prevents undue stretching (*i.e.*, strain) of the ligaments as the result of intra-abdominal pressure. In accordance with these propositions the primary supports of the uterus are its ligaments, while the secondary support is the pelvic diaphragm. If we accept these propositions as true, and believe that the cardinal ligaments are the main element holding the uterus at a more or less definite level in the pelvis the causation and treatment of prolapsus uteri become comparatively simple. The treatment will be primarily directed to the ligaments, and above all to the cardinal ligaments, and secondarily to the pelvic diaphragm. The following cases, operated on in the Perth Hospital, illustrate these principles of treatment.

Case I.—Mrs. B., forty-eight years, 10 children, youngest twelve years, irregular menstruation. The cervix projected over an inch outside the vulva on standing, and required to be shoved

back to permit of sitting; it was lacerated and hypertrophied, while the external os and surrounding area was red and eroded. The cervix first protruded over two years earlier. There was marked cystocele as well as some rectocele, with diastasis of the levatores ani from an old perineal laceration. Suprapubic abdominal cœliotomy was performed on July 9, 1913. The bladder was thrown down from the uterus after breaking down adhesions of the bladder right up to the fundus uteri. In then separating the

FIG. 1.



The cardinal ligaments (*c*, *c*) are looped on to the anterior uterine surface, the utero-vesical pouch having been opened and the bladder thrown down from the uterus. The loops (*L*, *L*) in the round ligaments correct retroversion, the internal muscular parts (*M*, *M*) of the ligaments being encroached upon as little as possible.

bladder from the uterus an adventitious cyst with smooth lining and about two inches broad was opened into. The attempt to dissect it off the uterus was partially abandoned because of free hemorrhage. The cardinal ligaments being then exposed were dissected off the posterior layer of the broad ligament, and looped up on the anterior wall of the uterus, to which they were sutured with silk. After taking a loop in each round ligament, the wound in the peritoneum was closed with a continuous catgut suture. The utero-sacral ligaments were so attenuated by stretching that they could not be certainly identified. On attempting to " manufacture " them by stitching the posterolateral margin of the uterus to the peritoneum lateral to the rectum, the stitches tore out on account of the friability of the peritoneum in an obese person. The patient did well after operation, a striking feature being that in this case as in subsequent ones there was practically no post-operative shock. Three weeks later large wedges were re-

moved from the hypertrophied cervix, a procedure which proved difficult from the impossibility of drawing the uterus far down the vagina without using undue force. At the same sitting, anterior colporrhaphy, and colpoperineorrhaphy were carried out. The final result was all that could be desired, the uterus being normal in size, fixed well up in the pelvis in its normal anteverted position, and the patient feeling unusually well. Recently I saw her looking splendid, menstruating regularly, and about to set out to confine her daughter.

CASE II.—Mrs. W., forty years, 3 children (youngest three months). Procident uterus for last 2 years, reaches vulva after exertion. Lacerated perineum (unrepaired) at first confinement 4 years ago. The abdomen was opened, after curettage, on September 10, 1913. Looping of the cardinal ligaments and of the round was carried out as in Case I, thus placing the uterus in its normal position in the pelvis. Finally, there was nothing to show that an operation had been performed in the abdomen except a two-inch suture line in the uterovesical fold of peritoneum, and this could only be seen when the fundus uteri was pulled backward. A fortnight later the diastasis of the levatores ani was remedied by a perineorrhaphy, and the patient left hospital restored to a normal condition as far as examination could show.

CASE III.—Mrs. R., forty-six years, 10 children (youngest seven years), some metrorrhagia. For the last two years the cervix uteri has projected for about an inch after any physical exertion. It was much hypertrophied, and there was erosion around the external os. There was cystocele and rectocele, with marked diastasis of the levatores ani, the muscles having retracted almost to the bones. The uterus was a good deal enlarged, heavy, and congested, and by the abdomen was found to be œdematous. The patient looked much older than her age, was edentulous, flabby and nervous, the first heart-sound at the apex was weak, and the aortic second sound accentuated. On October 27, 1913, after curettage and removal of wedges from the cervix, the abdomen was opened and looping of the cardinal and round ligaments carried out, the uterus being thus restored to its normal position in the pelvis. The patient's condition caused anxiety to the anæsthetist, so that she was never completely under the "open ether" administered, thus rendering the operation very difficult and unduly prolonged. In spite of this the patient showed practically no evidence of post-operative shock, and made little com-

plaint of pain. In this and Case II the upper free margins of the superior heads of the cardinals were beautifully defined. Some weeks later the cystocele was found to have greatly diminished, so that only the diastasis of the levatores ani was dealt with, and finally, the patient left hospital completely restored.

CASE IV hardly calls for description as it is merely a repetition of the remarkable success of the other cases.

CASE V.—Mrs. C. W., twenty-nine years, married 5 years, 3 children (last aged nine months), no miscarriages, menorrhagia. She complained of the uterus "coming outside" for the last 8 months. On examination the cervix uteri was found markedly hypertrophied, ulcerated from friction, and cutaneous from long exposure to the external air. With a very trifling pull a vulsellum drew the cervix about two and a half inches out from the vagina, and demonstrated marked cystocele together with rectocele, and associated diastasis of the levatores ani. The uterus was curetted, and large wedges excised from the cervix. A fortnight later—November 25, 1913—the abdomen was opened, and the cardinal and round ligaments looped. On immediate examination in the lithotomy position, the uterus was found to be beautifully fixed in its normal position in the pelvis, the firm fixation being demonstrated by pulling on the sutures which had been used in excision of the cervical wedges. It was also noted that the cystocele and rectocele were much less pronounced. No further operation was done at this sitting because of the presence of a small abscess about the vulva, and unfortunately the patient declined a suggested perineorrhaphy. When she left hospital the uterus was in perfect position.

As to the above operation of intra-abdominal looping of the cardinal ligaments, I trust other surgeons may be encouraged to give it a trial. Certainly it is not an operation to be lightly undertaken, but once the anatomy of the uterine vessels and of the ureter is clearly grasped the danger is greatly minimized. If the operation, with a gradually perfected technic, turns out to be all that I anticipate, it should greatly advance the treatment of uterine prolapse. Its more striking advantages are: (1) The practical absence of hemorrhage; (2) the excellent immediate anatomical result, and almost certain good permanent effect; (3) the comparative absence of post-operative shock, and (4) the absence of raw surfaces.

SIMPLE AND COMPLETE FORMS OF APPARATUS FOR INTRATRACHEAL ANÆSTHESIA.*

BY HENRY H. JANEWAY, M.D.,

OF NEW YORK.

(Published from the Department of Experimental Surgery of N. Y. University and Bellevue Hospital Medical College.)

IN the August number of the ANNALS OF SURGERY for 1912, an apparatus for the administration of intratracheal anæsthesia was described for which the advantages of compactness in size and ease of transportation were claimed.

Since that time the apparatus has been improved; both its weight and size have been materially diminished. Because of the useful field which intratracheal anæsthesia is destined to fill, improvements of these characters justify a brief description.

Fig. 1 represents an apparatus which is fitted with only those parts which are considered necessary for intratracheal anæsthesia. It weighs eighteen pounds and measures 15 x 4½ x 5. It may be taken apart into three pieces, by removing the pins in the base plate, and can be carried in a small handbag. It is provided with a safety valve and air filter.

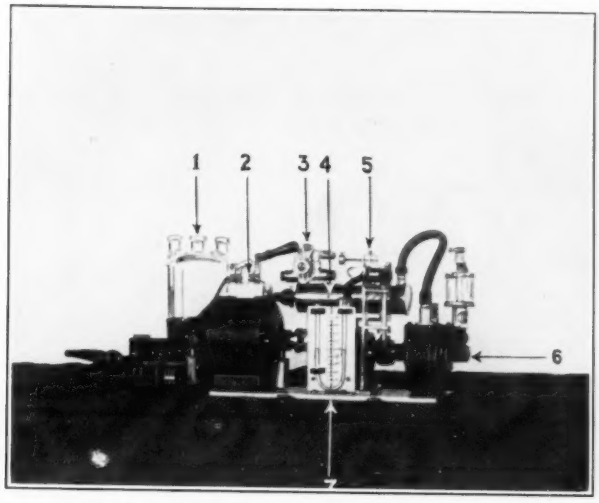
Fig. 2 illustrates a machine designed for hospital work but easily portable. All the parts are attached to one base plate. In addition to safety valve, air filter, and ether jar, it contains provisions for warming and moistening the current of air and for automatically interrupting the same at desired intervals. It runs noiselessly and measures 14 x 10 x 8 inches and weighs 28 pounds.

Fig. 3 illustrates an apparatus containing all the parts mentioned in the description of the machine represented in Fig. 2, but in addition, provision for measuring accurately the current of air and percentage of ether vapor. All these parts are fixed upon one base plate. It weighs 35 pounds and measures 19 x 10 x 8 inches. Dr. Karl Connell has demonstrated the constancy with which definite ether percentages may be adhered to during anæsthesia. This work has been confirmed by Boothby, of Boston, and the author is convinced of the truth of these claims. Ether may, therefore, be administered with greater scientific accuracy and safety to patients when it is possible to accurately control the percentage given.

In this machine the varying quantities of ether are delivered to the vaporizing jar by a piston which can be set to deliver any desired quantity per minute. The quantity of air is measured by the height to

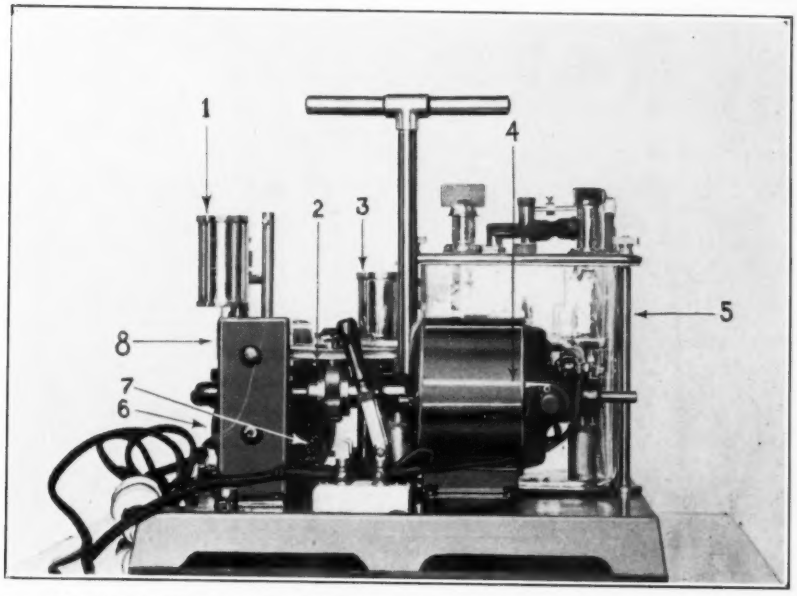
* Read before the American Association of Anæsthetists, June 18, 1913.

FIG. 1.



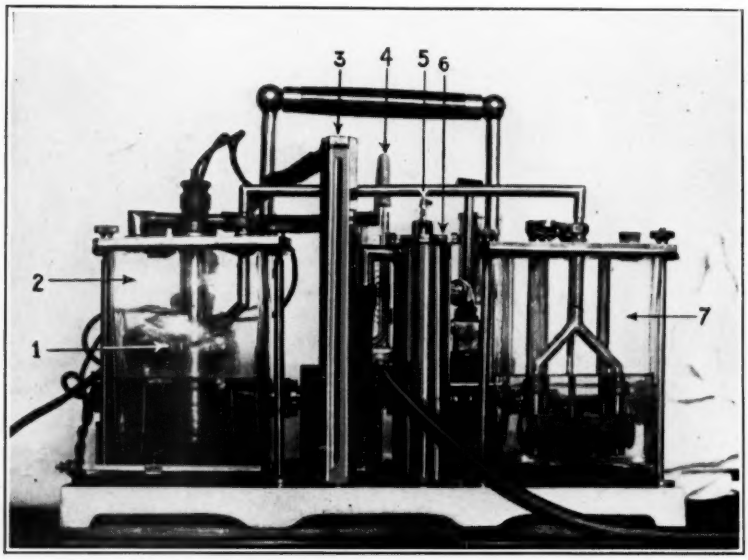
Smallest apparatus for intratracheal anæsthesia, measuring 4½ x 5 x 15 inches and weighing 18 pounds. 1, ether flask; 2, motor; 3, slide valve controlling the percentage of ether administered; 4, air filter; 5, safety valve; 6, blower; 7, manometer.

FIG. 2.



Complete apparatus for intratracheal anæsthesia except for means for measuring ether percentages. Weighs 28 pounds and measures 10 x 14 inches. 1, muffler and air filter to intake of blower; 2, worm wheel which operates the interrupter to the current of air; 3, second air filter between the blower and ether flask; 4, motor; 5, ether flask; 6 and 7, blower; 8, gear box.

FIG. 3.

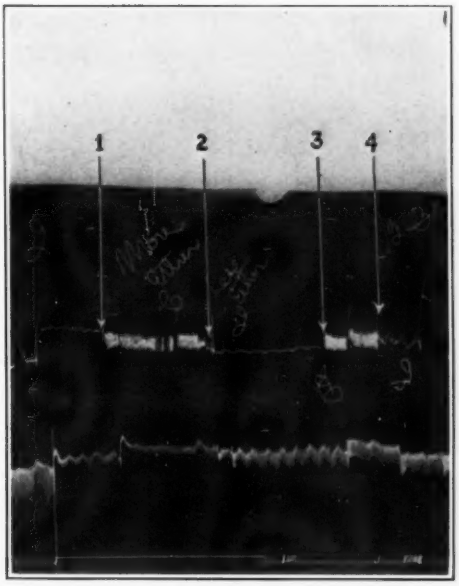


Apparatus for intratracheal anæsthesia with provisions for measuring ether percentages. Weighs 35 pounds and measures 19 x 10 x 8 inches. 1, motor seen through the volatilizing flask; 2, volatilizing and warming flask; 3, air meter; 4, manometer; 5, safety valve; 6, air filter; 7, ether flask

FIG. 4.

Showing diminution of blood-pressure and output per heartbeat when intrabronchial pressure was raised from 10 to 22 mm. Upper tracing measures the output per beat of the heart. Lower tracing measures the blood-pressure.

FIG. 5.



Illustrates effect upon respiration when the current of air is interrupted with the thoracic cavity open. Upper tracing, the respiration curve; lower tracing, the blood-pressure curve between 1 and 2, and between 3 and 4 the current of air was not interrupted.

FIG. 6.

Illustrating the position of the head of the author's self-lighting speculum for catheterizing the trachea. The speculum is roofed to the distal end, which is curved in a manner to direct the distal end of the catheter forward from the œsophagus and into the larynx and yet it permits of a direct view of the larynx. The battery is enclosed in the handle.

which a float rises within a perpendicular tube, the lumen of which is shaped like a truncated cone. The higher, therefore, that the float rises the larger is the circular space around it and between it and the walls of the tube. This form of meter works accurately and may be tested at any time in the offices of any gas company.

We have tested it by a wet meter purchased for the purpose and have found no variations during a period of several months.

All these machines work on both the alternating and direct current.

When the author first used this machine he was not entirely assured that the administration of ether in known percentages offered a material advantage, especially if the services of an expert anæsthetist should be at hand. In whatever manner ether is administered, the physiological effect upon the patient is the only safe guide to the amount of ether which should be given. While it always is a satisfaction to know the amount of air and the percentage of ether which the air contains, this knowledge can only be obtained at the expense of adding to the apparatus extra parts for this purpose.

Continued use of the machine has convinced the author that a knowledge of both the amount of air and the quantity of ether administered per minute is more than a satisfaction. It prevents, on the one hand, inconveniences amounting sometimes to actual dangers from the use of improper quantities of air and renders possible the administration of ether with far greater accuracy.

The device for mechanically interrupting the current of air is to be viewed in the same light. Regularly interrupting the current of air makes no difference in the blood-pressure, when the current of air is supplied within the pressure limits which are indicated during intratracheal anæsthesia.

It is well to remember that at a high pressure, which sometimes may occur accidentally, the pulmonary circulation can be sufficiently compressed to reduce seriously the output of the heart and the general blood-pressure. This change is illustrated in Fig. 4.

The great benefit from regularly interrupting the current of air is noticed during intrathoracic operation when the thorax has been opened. Fig. 5 illustrates the contrast during the same

stage of anæsthesia between the excessive respiration occurring when a constant current of air was supplied and the almost entire cessation of efforts at respiration during the periods in which the current of air was regularly interrupted.

The arrangement for automatically interrupting the current of air on these machines, in no way complicates them and is preferable to relying upon the anæsthetist for their production.

It will be noticed that all these machines are open and simple in construction. All parts are easily reached.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, held at the New York Academy of Medicine, December 10, 1913.

The President, Dr. Frederic Kammerer, in the Chair.

FRACTURE OF THE HEAD OF THE RADIUS.

Dr. William Darrach showed two cases, with stereopticon illustrations of the X-ray findings. The first patient was a woman, twenty years old, who, on January 10, 1912, fell, striking on her right elbow. There was sharp pain over the radial head, with greatly impaired function. On the day following the injury, after an attempt at reduction under chloroform, the X-ray showed two loose fragments and an operation was advised. At this time there was great tenderness over the radial head, which was increased by pronation and supination. The head of the bone moved with the shaft. Flexion was limited to 45 degrees; extension to 150, while pronation and supination were slightly limited.

Operation, January 18, 1912: With the elbow flexed to 90 degrees, a curved incision was made over the dorsal aspect of the radiohumeral joint; this was deepened through the external lateral and orbicular ligaments, and the joint was opened. One fragment, which was loose and quite separate from the rest of the bone, was easily removed, but a second piece was dislodged with some difficulty, as it lay deep in the wound. Its removal was accomplished, however, and the wound was then closed with catgut and silk. The first dressing was made on the fifth day, when the stitches were removed. The wound healed primarily, and motion was begun on the tenth day. An X-ray, taken about a fortnight later, showed that a third fragment had been overlooked, but as flexion was then possible to 50 degrees, no attempt was made to remove it.

At the present time, 23 months after operation, there was flexion to 35 degrees, but extension was limited to 160 degrees, apparently by bony contact. Pronation and supination were complete. There was no pain nor decrease in power. The indications for operation in this case, the speaker said, were the faulty position and complete separation of the fragments.

Dr. Darrach's second case of fracture of the head of the radius was that of a man of thirty-two, who, on February 18, 1913, fell off the lowest step of a ladder, striking on the outer aspect of his left elbow against a concrete floor, the elbow resting against his side. Following the injury there was a moderately sharp pain over this region, and the forearm hung limp. It was bandaged and put in a sling and then put up in plaster for two weeks. After an X-ray was taken, an operation was advised, and the patient was brought to Roosevelt Hospital.

On the seventeenth day after the injury an incision was made over the dorsal aspect of the radiohumeral joint, and an attempt made to replace the loose fragment, which consisted of the outer half of the head, and a small portion of the neck. This was unsuccessful, and it was removed. The wound was then closed, and the arm put up at right angles in a starch bandage. When the bandage was removed and the stitches taken out twelve days later, the wound was firmly united. At this time there was flexion to 85 degrees; extension to 130 degrees; pronation 20 degrees, and supination 60 degrees. A week later there was flexion to 70 degrees, extension to 145 degrees, 60 degrees of pronation and 75 degrees of supination. Eight months after the operation there was flexion to 45 degrees, extension to 165 degrees, with 90 degrees of pronation and supination.

Dr. Darrach said it should be possible to replace a single fragment, providing it did not involve too much of the head of the radius and the attempt was made sufficiently early. In this case, which was done on the seventeenth day, there was too much new tissue deposited to allow of accurate apposition.

Dr. John A. Hartwell reported the case of a young woman who fell through a plate glass door, striking on her arm and receiving a fracture of the head of the radius, of which the speaker showed an X-ray picture. The injury was first treated by flexing the arm at a right angle and later by partial flexion. At the present time, the patient had good function, with practically complete flexion, but some limitation of extension.

DR. ELLSWORTH ELIOT, speaking of the presence of loose fragments in fractures of this nature, said he did not think they were of any special harm, irrespective of their position, but by becoming attached to some part of the articular surface, they might readily interfere with motion, particularly with extension and possibly with rotation. Two or three years ago he had a case where the X-ray showed multiple small fragments. After opening the joint, he introduced a small Nelaton catheter and washed out the joint with sterile saline solution, and during this process the small particles of bone came away. Some of these were as large as a pea, while others were very small fragments, and could not readily have been removed in any other way. An irrigation of the kind is almost certain to remove them and that too, with the least degree of trauma to the joint structures.

DR. JAMES M. HITZROT reported the case of a girl, twenty-six years old, who fell forward, striking on her extended hand. An X-ray was taken, which showed an injury similar to that portrayed in Dr. Darrach's first case. Upon opening the joint, he found a fracture through the head of the radius, and of the capitellum, with a fragment of the capitellum engaged in the fracture line. In this case, Dr. Hitzrot said, he removed the head of the bone, because he had seen several cases where supination was more or less interfered with when the fragment was left behind. In his own case, of which he showed the specimen, the woman obtained excellent function in spite of the fact that the head and part of the neck of the bone were missing.

DR. DARRACH said they had had in the Out-Patient Department 20 cases of fracture of the head of the radius, during the last three years, which had been treated without operation. Of ten of these, whose X-ray plates had been gone over, five showed a fissured fracture of the head, with slight or no displacement, and the other five showed a fracture of the neck with more or less impaction. The results in these, as far as they had been traced, were satisfactory. Some showed a little limitation of pronation and supination, and many of them showed slight limitation of extension. In cases where there was little or no displacement of the fragments, it was wise, the speaker thought, to try conservative methods.

In addition to the cases shown, Dr. Darrach said he had operated on five other injuries to the radial head. One comminuted

fracture of the head, where the whole head and neck was removed, showed perfect supination and pronation, and perfect flexion and extension. In two anterior dislocations of the head, associated with fracture of the ulnar shaft, the head and neck were resected in one case, with complete restoration of motion, while in the other case the dislocation was reduced, after re-fracture of the ulna, by cutting through the orbicular ligament. The remaining two cases were fractures of the radial head associated with posterior dislocation of the ulna at the elbow. The head and neck were removed in both. Pronation and supination were restored, but there was limitation of flexion and extension due to other causes.

When the loose fragment involves a considerable portion of the internal aspect of the radial head, it is wiser, Dr. Darrach thought, to remove the whole head and neck. Otherwise, the changes at the superior radio-ulnar joint would materially interfere with pronation and supination.

PYLOROPLASTY FOR GASTRIC ULCER.

Dr. James M. Hitzrot presented a laborer, twenty-nine years old, who was admitted to the New York Hospital on January 27, 1913, complaining chiefly of a pain in the right upper quadrant of the abdomen. He stated that he had suffered more or less from abdominal pain for the past fourteen years. In October, 1911, he had been operated on for cholelithiasis, and in the following February the abdomen was again opened, when a " wound in the gut " was repaired. Following this second operation he had an attack of vomiting about every three weeks, associated with severe epigastric pain. On July 1, 1912, a gastro-enterostomy and appendectomy was done at the Mayo Clinic, and following this operation the patient had remained perfectly well for three months.

Present History: For ten weeks prior to his admission to the New York Hospital the patient had suffered from pain in the right upper quadrant, just below the costal margin. This pain was intermittent in character, and at times was so severe that he had fainted. It radiated through to the back, but never upward to the shoulder blades, and usually came on from half an hour to one hour after taking food.

Examination showed an indefinite mass on deep respiration

in the right kidney region. There was a small hernial protrusion through a scar of the right rectus, with considerable tenderness over the upper part of the scar. Several blood counts were taken, which showed 100 per cent. of hæmoglobin, with 6,000,000 red cells, 15,000 leucocytes, and 64 per cent. of polynuclears. The von Pirquet test was strongly positive within twenty-four hours.

Operation by Dr. Hitzrot, February 4, 1913: A right rectus incision was made above the umbilicus through the old scar, and upon entering the peritoneal cavity, a mass of adhesions was found, especially about the gall-bladder. The pyloric region was freed from adhesions, and upon examining the stomach, the old gastro-enterostomy opening was found to be closed. The pyloric ring was narrowed and indurated, especially anteriorly and on the duodenal side of the pylorus. A typical Finney pyloroplasty was done, and on completing the anastomosis between the stomach and the duodenum, the opening was large enough to easily admit the tips of three fingers. The wound was then closed, a small cigarette drain and two pieces of gauze packing being left in the abdomen for drainage.

The wound healed primarily, and the patient was allowed up on the tenth day. He was discharged on February 15, 1913, and since then had been entirely relieved from pain and other symptoms of gastric disturbance. The diagnosis in this case was chronic ulcer of the stomach.

Dr. Eliot said that recently he had been interested in the radiographic findings of the passage of bismuth through a gastro-enterostomy orifice. From a number of cases which he had studied, including not only those within a month after operation, but also those in which an interval longer than a year had elapsed, the size of the opening seemed to make little difference. In each instance only a very small-sized stream of bismuth found its way through, and he had come to the conclusion that most of the bismuth passed through the pylorus and comparatively little through the gastro-enterostomy orifice.

Dr. Arpad G. Gerster said he recalled a very important and interesting observation regarding the closure of the gastro-enterostomy orifice that occurred about six years ago in the practice of Dr. J. Kaufmann. The patient, Dr. Gerster said, came under his care on account of a gastrocolic fistula, as the result of which he was passing formed fæces through his mouth. Several years

prior to that time he had had an ulcer of the pylorus, for which a gastro-enterostomy was done by Dr. F. Lange. Dr. Lange followed the usual method of those days, also doing an entero-enterostomy—the Y-shaped operation first practised by the French surgeon Roux.

Dr. Gerster said that when he came to operate on this patient, he found that the entero-enterostomy, so far as the adhesions between the two segments of the small intestine were concerned, still persisted, but the communication between them had been obliterated. The site of the gastro-enterostomy, however, could not be located. The openings in stomach and jejunum had not only been obliterated, but the adhesion between the stomach and small intestine had been entirely resolved and abolished. The pylorus had resumed the normal shape, so that the finger could be invaginated through the pylorus into the duodenum. This, the speaker said, was the usual course of events, and as soon as it took place, the gastro-enterostomy orifice closed. If the ulcer recurred, as it was very apt to do, because the operation did not obliterate the patient's vice to re-form ulcers, then we had to deal with a renewal of all the symptoms. As long as there was irritation, adhesions would form, and with the cessation of irritation, adhesions would have a tendency to be abolished and the normal conditions to be re-established.

MULTIPLE LIPOMATA.

Dr. Hitzrot presented an Italian, forty-three years old, who was admitted to the New York Hospital on December 1, 1913, with the history that about three years ago he first noticed several small, soft masses on his shoulders and the back of his head. These increased rapidly in size and during the past six months one of the tumors on the back of his neck had become painful. Eight months ago, two similar growths appeared on the anterior abdominal wall.

Examination showed multiple tumors of varying size over the body and extremities. These were lying underneath the skin, soft, globulated and painless. There was a mass, the size of a lemon, on each side of the posterior surface of the arms between the elbow and shoulder. A small tumor could also be felt beneath the right mammary gland, and similar masses were found on the anterior abdominal wall, on both thighs, over the clavicle and the anterior surface of the forearms.

On December 4, 1913, Dr. Hitzrot removed the tumor on the right side of the neck, which was giving rise to pain. Its removal was accomplished with some difficulty, because of the presence of dense, fibrous adhesions.

Dr. Hitzrot said there was no history of alcoholism in this case, and there were no physical signs of any tuberculous process in the lungs.

Dr. Charles A. Elsberg said that four or five years ago Dr. John F. Erdmann showed a case of multiple symmetrical lipomata, and three or four months prior to that time the speaker said he had presented a similar case, shortly after Marie had described the condition of symmetrical adenolipomatosis. Marie contended that these lipomatous growths contained adenoid tissue, that the condition was usually met with in alcoholics and that the patients were apt to succumb to tuberculosis. In his own case, Dr. Elsberg said, the patient died three or four years later of pulmonary tuberculosis.

Dr. Otto G. T. Kiliani said that at one of the meetings of the Society at the German Hospital, he showed a case of symmetrical lipomatosis involving the arms and abdomen, and the case was subsequently published, with a photograph, in his book on Surgical Diagnosis. In that case he removed one of the large tumors, and when he last saw the patient, about six months ago—perhaps eleven years after the operation—he found that a number of the smaller growths that had been left had greatly increased in size. The patient was otherwise in good health and showed no evidence of any pulmonary trouble.

PERFORATING TYPHOID ULCER.

Dr. Otto G. T. Kiliani presented a young man who was admitted to the German Hospital on October 6, 1913, with the history that he had been feeling ill for two weeks. During this period he had suffered from cough and frequent vomiting, followed by abdominal pain, diarrhœa, chills and fever. He had remained at work.

On admission, the patient complained of pain and tenderness under the left costal margin, and of great weakness. The lungs gave evidence of a diffuse bronchitis. The abdomen was soft, and slightly distended, with some tenderness in the appendicular region and numerous "rose spots." The spleen was enlarged.

The temperature, on admission, was 104.5°. Three days later it rose to 106.5° and then suddenly dropped to 97°. Accompanying this the pulse was weak, but low, and the patient complained of a fairly acute pain on the right side of the abdomen, below the navel. There was slight rigidity of the right rectus, together with exquisite tenderness in the right lower quadrant.

The case was recognized as one of perforating typhoid ulcer, and when Dr. Kiliani opened the abdomen through the outer edge of the right rectus, he found four or five intestinal ulcers, one of which had perforated, while the others appeared ready to perforate. He thereupon resected the appendix and used its mesenteriolum to cover the perforation of gut. He then simply washed out the abdomen and closed the wound, without drainage.

Following the operation, the patient's temperature again rose to 105.5°, and the case ran an uneventful typhoid course for four days, when symptoms of retention developed, with a sudden drop in temperature and evidences of a second collapse. Upon investigation it was found that the abdominal wound had broken down and showed evidences of infection. The wound was cleansed and permitted to remain open, and from that time on, with the exception of two relapses, the typhoid fever ran its usual course and the patient's further recovery was uneventful. He now had a large hernia, however, at the site of his abdominal wound.

In connection with these cases, Dr. Kiliani said, the question arose whether to drain or not to drain. The chief objection to drainage was that we left a foreign body in contact with the inflamed gut and were thus apt to produce further perforations.

Dr. William C. Lusk said that he had recently operated upon a case of typhoid perforation, who recovered, at Bellevue Hospital in the service of Dr. T. A. Smith. Through the Kammerer incision he had closed the perforation, which was situated about five inches from the ileocæcal valve, using one continuous stitch of No. O chromic gut to bring together the edges of the perforation, and two outer rows of Pagenstecher linen thread inverting the first stitch line. Seropus which was found on the right side and in the pelvic cavity was removed with the Kenyon and Pool aspirating nozzle (*Surg., Gyn. and Obstets.*, December, 1909). A glass drainage tube was placed in the pelvic cavity through a suprapubic stab wound, and a gauze strip introduced within it. The deep transrectus wound was closed in two tiers

with chromic sutures, the deeper row being mattress sutures which included peritoneum and rectus muscle. A rubber tissue drain was inserted down to the rectus muscle in the lower angle of the wound. On the third day smears from the pus in the bottom of the glass drain did not show the presence of any bacteria. After a few days the abdominal incision broke open, a loop of adherent intestine presenting prominently in the interval. This piece of bowel was gradually reduced into the abdominal cavity and the skin edges finally drawn closely together by strapping the wound with adhesive plaster.

Regarding peritoneal drainage Dr. Lusk said that Petroff, of Warschau (*Zentralbl. f. Chir.*, No. 31, 1913, p. 1215), by experiments on 37 rabbits had demonstrated that the removal of fluid from the peritoneal cavity was most effectually accomplished by means of glass drains with wicks, since a drain of this sort stimulated the formation of hardly any adhesions and would continue to abstract fluid out of the general peritoneal cavity for more than 48 hours, while gauze was effectual to drain for only 5 to 6 hours. He also said he regarded that the recovery of this case was due not entirely to an early diagnosis having been made, the patient having been operated upon just 3 hours after the occurrence of the perforation, but in large measure as well to the fact that the patient had been fed with the high caloric diet originated by Dr. Warren Coleman (*Am. J. Med. Soc.*, January, 1912) as a therapeutic measure in the treatment of typhoid fever. Thus, this patient instead of coming to operation for an acute peritonitis, emaciated and delirious as was usual under the former methods of treatment, was very well nourished, in a normal state of mind, and consequently in a favorable condition to resist the ordeal necessitated by his complication. The patient suffered no shock from his operation and except for the suppuration and opening up of the wound, recovery was uneventful.

Dr. Kiliani rejoined that in most of the cases of operation for perforated typhoid ulcer which had come under his observation where the wound had been closed without drainage, the sutures had subsequently given way. He had no explanation to offer why this was so, but he had an impression that if the sutures had not given way in these cases, a fatal issue would have been more apt to occur. He recalled another case reported to the Society, 1906, where there were two perforations of the ileum

and one of the gall-bladder. The man was apparently progressing favorably after the operation, but he succumbed on the tenth day from pneumonia.

Dr. Killiani said he had seen the statement that 25 per cent. of these cases were saved by operation. These figures seemed to him rather high, unless we took into consideration the fact that the favorable cases were more likely to be put on record than those that had resulted unfavorably.

Dr. Clarence A. McWilliams said they had had 20 cases of perforated typhoid ulcers at the Presbyterian Hospital up to three years ago, with five recoveries after operation—25 per cent.

HERNIA OF THE LARGE INTESTINE, WITH SPECIAL REFERENCE TO "SLIDING HERNIA."

Dr. A. V. Moschcowitz presented a paper with the above title, for which see page 610.

Dr. Arthur S. Vosburgh said the paper of Dr. Moschcowitz and his diagrams of sliding hernia were a great help to the clear understanding of this subject. When a year or so ago he read Dr. Hotchkiss's paper on the treatment of sliding hernia, he was unable to follow clearly the steps there described in the treatment of the sac. Not until he had a case of sliding hernia of the ascending colon, and had attempted to describe to the house surgeon the method of repair, had he fully appreciated the difficulties of a written description.

In a recent case, that of a very old man, operated under novocaine, he came down upon tissue that did not seem to belong to a hernial sac. Incision of this tissue excited free bleeding, and further attempts to enter the sac at this point were abandoned. The peritoneal cavity was entered in the neighborhood of the internal ring, and then the explanation of the condition was clear. A sliding hernia of the ascending colon, the tissue that bled freely on incision, was the non-peritoneal surface of the ascending colon, being covered by the lymphatics and blood-vessels that supply the ascending colon. On inspecting the neck of the sac, it was found that the ascending colon occupied two-fifths of the ring. If approach to the sac from this side had been persisted in, the lumen of the gut would have been entered, and much damage to the blood supply of the colon would have resulted. Recalling Dr. Hotchkiss's paper, his description of the treatment of the sac was then

perfectly clear. Splitting the sac longitudinally he apportioned two leaves, to form a new mesentery for the colon, pushed the colon well into the abdomen, and anchored it there. The mouth of the sac was then closed with purse-string suture, and the inguinal canal repaired in the usual way.

Dr. L. W. Hotchkiss said he had seen a number of these cases of "sliding hernia" at Bellevue Hospital and elsewhere. The patients were usually adults, past middle life, with a moderate-sized hernia which it was very difficult to control with a truss. In the first case he saw, the hernia involved the descending colon and the sigmoid flexure. Operating by the method then devised to meet the emergency, and which he has described, he found that the contents of the sac were easily replaceable: *i.e.*, by splitting the sac well down in front he formed a sort of mesentery which allowed the gut to be replaced without injury and then the rest of the opening was closed by purse-string suture in the usual manner. Subsequent to that he encountered several of these cases in succession, and the operation he had devised gave admirable results in dealing with these cases, the smaller sliding herniæ of the right side as well as the large sliding variety on the left side.

Dr. Burton J. Lee said that about three years ago he saw a case of "sliding hernia" on the right side, and on operation it was found to include the ascending colon. The case resulted fatally from acute intestinal obstruction and peritonitis. In this case, the speaker said, the fatal result had been due to a replacement of the bowel directly inward, rather than upward and outward behind the peritoneum.

Dr. William B. Coley said he had been much interested in the subject of "sliding hernia" for many years, and a large number of these cases had come under his observation at the Hospital for the Ruptured and Crippled and at the General Memorial Hospital. He did not quite understand why Dr. Moschcowitz advanced such an arbitrary rule in regard to the pathogenesis of the condition, as it was at variance from that long held by other men and with his own experience.

Dr. Coley said that in spite of theoretical objections regarding its etiology, we must recognize that this form of hernia, sliding hernia of the cæcum, does occur. Personally, he was inclined to believe that it was the result of a congenital malformation, and

that, while the cæcum may be covered by mesentery, in certain cases it was not.

Finsterer (*Beitr. z. klin. Chir.*, November, 1912, Bd. 81, p. 198) recently reported three cases of sliding hernia, two of which were of the cæcum. Hilgenreiner in his statistics, comprising 2238 cases, reported 8 cases in which the cæcum formed part of the sac.

At the Hospital for Ruptured and Crippled, up to December, 1912, the sigmoid was found in the sac 5 times; the cæcum alone in 7 (these cases were of the sliding variety), the appendix alone was found in 15 cases.

As to the operative treatment of sliding herniæ, the speaker thought the method advocated by Dr. Moschcowitz was a very excellent one and was similar to that described by Dr. Hotchkiss. Dr. Coley stated that in certain difficult cases, he believed that the procedure described some years ago by Fiaschi, of Sydney, Australia, in which the cæcum or sigmoid, after reduction, is fastened by suture to the anterior abdominal wall, was a good one; in ordinary cases, he had not found it necessary.

Dr. Moschcowitz, in closing, said that while with the ordinary variety of "sliding hernia" the descending and ascending colon only were involved, even the small intestine might be involved, and he recalled one case of Dr. Gerster's where there was a "sliding hernia" of small intestine. We could imagine a very large hernia on the left side with the entire mesosigmoid unfolded, then we would have a "sliding hernia" of the sigmoid flexure, but not until then. A "sliding hernia" of the bladder was very common, and the speaker said he had seen a "sliding hernia" of the uterus, but the common variety was that of the ascending or descending colon and not of the sigmoid flexure.

BOOK REVIEW

SURGERY OF THE EYE. By EDWIN TOROK, M. D., and GERALD H. GROUT, M.D., p. 485. Lea & Febiger, Philadelphia.

The plan of this book as outlined in preface, namely, the disease, the selection of operation, detailed steps of operation, list of instruments required, complications and first operative care, is followed closely and admirably carried through the book.

The first part, covering 120 pages, deals with general surgical methods. In twelve pages the post-operative complications are ably and concisely discussed.

Pages 65 to 121 are devoted to a systematic description of instruments and their uses and contain valuable hints to beginners.

Part II is prefaced by eight pages on the surgical anatomy of the eyeball and in the remaining 337 pages the operations on the eyeball and appendage are taken up in logical sequence.

The book finishes with a chapter of sixteen pages on removal of foreign bodies.

Among the more recent operations and those not described in detail in the current surgical text-books are Legrange's sclerectomy and sclerecto-iridectomy, Heine's cyclodialysis, Elliot's trephining of sclera, Toti's operation on nasal duct. The technic in use of Schiotz tonometer, and the technic of keratoplasty.

This book is well written, compact and yet as comprehensive as was possible in 400 pages. It may not give quite the personal touch or impart the individual experience noticeable in some edited in recent years but the selection of operation and methods are well chosen and painstakingly described. The description of the more modern operations will be appreciated.

One excellent feature of the book is its wealth of original illustrations which, together with the concise and lucid text, can hardly fail to impart to the beginner a good understanding of the operation in question. Altogether this volume is a distinct contribution to the existing books on ophthalmic surgery.

P. CHALMERS JAMESON.

INTERNATIONAL SURGICAL ASSOCIATION.

THE Fourth Congress of this Association will be held at the Hotel Astor in New York City lasting four days, beginning Monday April 13, 1914. This is the first time that the Congress has ever had a meeting outside of the City of Brussels, where the first one was held in 1905 and repeated every three years. The membership of the Association is limited to a certain number from each country. The membership in the United States is about one hundred. The President of the Fourth Congress is Professor Depage of Brussels, Professor Willems of Ghent is President of the International Committee, and Dr. L. Mayer of Brussels is the General Secretary.

The programme is limited to consideration of three main topics:

First, Gastric and Duodenal Ulcers. Introduced by papers by De Quervain of Basel, Hartmann of Paris, Lecene of Paris, Mayo of Rochester, Minn., Moynihan of Leeds, Payr of Konigsberg.

Second, Grafts and Transplantations. Introduced by papers by Morestin of Paris, Villard of Lyons, Ulmann of Vienna, Lexer of Jena, and Carrel of New York.

Third, Amputations. Introduced by papers by Witzel of Dusseldorf, Ceci of Pisa, Kuzmik of Budapest, Binnie of Kansas City, Durand of Lyons, and Ranzi of Vienna.

After the close of the Congress, Thursday, April 16, most of the foreign members will make a tour of other cities, the itinerary including Philadelphia, Baltimore, Washington, Chicago, Rochester, Minn., Montreal, and Boston.

To CONTRIBUTORS AND SUBSCRIBERS:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N.Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY,
227–231 South Sixth Street,
Philadelphia.